BRITISH SOCIETY
FOR THE
STUDY OF ORTHODONTICS

1950

Transactions of the

BRITISH SOCIETY FOR THE STUDY OF ORTHODONTICS

1950

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Mansion House, 26, Portland Place, London, W.1

Published for the Society by

Saward & Company, 1-5, *Honduras St.*, *London*, *E.C.*1

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Orthodontics In My Time

by H. T. A. McKeag, B.DENT. SC. U.DUB.

Can one man, with his partial view, in the course of an evening's talking epitomize the Orthodontics of thirty years? As I considered how that might be done, what at first sight was only a particular aspect seemed to take on an appearance of universality for the period, to summarize the past and illustrate how the present has grown out of it. Ideas govern practice, and it happened that I came into Orthodontic practice in circumstances which brought very forcefully to my attention what seems to me the essential difference in ideas that has dominated Orthodontics in my time.

The situation when I started was something like this: The Orthodontic horizon was practically filled by the Angle School, and by that I mean not merely the actual school in which Angle taught, though that was the centre of the set up; but the Angle School of thought, which was embodied in the institution, in the famous 7th Edition, and in the band of apostles formed by his former pupils, now in successful practice and contributing largely to Orthodontic literature and discussion.

There had been in Europe a School of Orthodontic thought and practice older than the Angle School, but one would have thought it was approaching extinction. The Angle School dominated America completely and its invasion of Europe seemed assured of conquest. Those who aspired to specialist practice on this side of the Atlantic went to America to study, and there there was a choice of the Angle School itself or study with one of Angle's pupils and devotees. Thus there was a fifth column in Europe, much more active and vocal than members of the European School, so that I was a considerable time in practice before I became conscious of the solid traditional foundations of the European School.

The essence of the Angle doctrine was that the dentition was potentially a normal dentition, and that if the Orthodontist failed to achieve a permanently normal relationship of the teeth the cause lay in his defective appliances or his defective operation of them. It was a religious duty, at any cost to operator or patient to conserve the 32 teeth and to go on striving for the attainable ideal.

The European School had no central doctrine. Almost one would have said that Orthodontic practice was for it a matter of individualists tackling individual malocclusions by the light of nature.

And yet gradually I became conscious that there was a conflict of view which went pretty deep. Superficially the difference between the two schools lay in the fact that the Angle School never extracted teeth and always used fixed appliances. But there was little public controversy over those differences. Those were the outward and visible signs of your inward and spiritual grace, and in public it was almost bad form to flaunt them in the presence of the poor misguided persons who acted otherwise. Indeed, if commonsense led you occasionally to use a removable appliance where it obviously served your purpose better you kept very quiet about it. And the extractionist, conscious

Presidential address presented to the meeting on 9th January.

of the weight of authoritative disapproval, and perhaps of the fact that some of his extractions were due to the deficiencies of his technique, tended to keep quiet on the subject too.

It was in other directions that the difference of outlook became evident. The implications of the Angle doctrine are numerous and far reaching, but they don't leap to the eye immediately. It follows from it that the origins of malocclusion are local and mechanical.

Intensive search was made for such causes, and it was demonstrably the case that they did operate and of course the fact that the mode of correction of malpositions of teeth is local application of pressure creates a *prima facie* case, in the absence of evidence of other causes, for such local pressure being the source of their departure from normal position. But did these undoubted local, mechanical causes explain all the conditions one met in practice? And were those practitioners who wrote and talked about heredity and malnutrition merely seeking excuses for their failures?

There was the further implication, boldly made by some adherents of the Angle School, that the Orthodontist could make bone grow by mechanical means, or as some claimed, by making normal function possible. It was clear that bone did appear where no bone was before, following the action of pressure. What but the pressure could have produced it, and if some bone could be added why assume a limit short of normal amount? At one stage in the career of the Angle School lectures were given by an artist on ideal facial form. Was it possible to mould an individual's face to a pattern other than that which his inherited make-up tended to give him, much less to impose on him an ideal form? Clearly it was possible to do something of that sort, but there must be limits. What were those limits, and what determined them?

It was another implication, that you intervened to correct a malocclusion as soon as you recognized it. But would correction in the deciduous dentition ensure normality in the permanent?

These were some of the questions that arose in practice and in teaching, and it was in trying to formulate these questions and to frame answers to them that I became conscious that there did exist a European School of Orthodontics, of which this Society was one of the main centres. The Angle School were, or seemed, unconscious of the questions for the most part, but there were others who clearly had long perceived the importance of them, and had even been putting forward answers, some were assertions, some reasoned arguments. More than that, it was clear that the difference in practice between the two schools was partly, at any rate, due to difference of general attitude on just such questions.

There was, thus, a body of dissenters, but it was not obvious that they had very much in common, and they seemed, to me, at any rate, to be fighting a rear-guard action in a general retreat. Whatever their arguments, the visible success in practice of the dominant school was a much stronger argument.

And yet it was only four years after I started in practice that there appeared a series of articles by A. F. Lundstrom which in retrospect assume an importance much greater than I, or I think most orthodontists, attached to them at the time. The title of the first indicated its scope — "Malocclusion regarded as a problem in connection with the Apical Base." It was not until four years later, when the same author's "Responsibility of the Operator for Relapse" appeared, that I realised that a full scale attack was being made on the whole Angle position by a former student of the Angle School and a practitioner and teacher of eminence. Then, in 1929 Professor Brash delivered a series of lectures on the Aetiology of Mal-

occlusion, subsequently published. The conclusion reached by Brash, in what he described as an essay in scientific scepticism, was that since the evidence for environmental causes as a general explanation of malocclusion was unsatisfactory there was a *prima facie* case for investigating heredity. That was not a conclusive demonstration of any major defect in current orthodontic theory, but it did seem to me that, coming at the time it did, Brash's book produced a very marked swing of opinion. I suppose one might say that experience had shown that working on the Angle assumptions did not always produce success, and practitioners were looking for something else to rest their opinion on.

Although in private conversation and to some extent in public discussion a change of attitude appeared in adherents of the Angle School it was not until some eight or ten years later that the change became fully manifest in Orthodontic literature. Recognition of the inadequacy of a basic doctrine does not necessarily involve public recantation. Men rightly prefer to declare their beliefs in positive terms, and there are many steps necessary between accepting the fact that some malocclusions could not be corrected by mechanical means and framing even a partial statement of what the possibilities and limitations are. We can, I think, now say with confidence that the central Angle doctrine has disappeared. Before I pass on to what has taken its place I want to ask you to look at the situation I have described in a rather different way. I have been using the names Angle School and European School, the first because it was a generally accepted term, the second because I could think of no better. But looking back now I see that the first of those at any rate is misleading when used for the school of thought which was dominant in the earlier part of my time. It is of course true that Angle was the pivot of the school. To describe it as the Angle school is misleading nevertheless in that it masks the fact that Angle and his students and the whole mode of approach to orthodontics were due to the nature of the dental educational system of the U.S. at the time the school was forming. American dental schools had grown up in response to a demand for technical training in dentistry, and so had grown up independently of medical education. Their curriculum had consequently a strong technical basis. It was natural that the product of such schools should think of their orthodontic problems in terms of mechanics, and the very great success which attended the concentration on mechanical procedure confirmed them in that approach. European dental schools, on the other hand, had been founded, and continued, as annexes of medical schools, and however much that cramped their development it did ensure that the student of dentistry was exposed to the influence of the biological sciences. His approach to any of his dental problems was inevitably coloured by the association with medicine. The fact that it was possible to speak of a European School of Orthodontics at all was due to the fact that there clearly was a body of orthodontists in Europe whose thought was permeated by biological science, and it was that difference in educational background which in reality determined, and almost constituted, the difference between the two schools of which I have spoken.

One other thing which I think should be said in this connection is this: there is a tendency to hold now that the Angle school set back, or held up, the development of orthodontics. I believe that is almost the reverse of the truth. What has happened is that a very large scale experiment has been made to test the validity of a simple hypothesis. The fact that the hypothesis has been shown convincingly to be untenable in its simple form is in itself a very great gain. But

it has been shown that there is very much more truth in it than would have been believed, without demonstration, by the adherents of the European School. New standards of achievements have been set up, and new additions have been made to the orthodontist's mechanical armoury. But there is this also, that the data available from this experiment are available to assist in laying down with some degree of precision the qualifications necessary to bring the hypothesis nearer the truth. And as regards E. H. Angle himself, I would like to record my conviction that Orthodontics owes more to him than to any other man. By focusing the tendencies of American thought on orthodontics into a simple and convincing doctrine and by his teaching and preaching he gave an immense impetus to orthodontics. And, above all, his influence was important because it was wholeheartedly idealist. The fact that human beings have turned out to be unworthy of the high facial destiny which Angle and his school designed for them need not diminish our regard either for his aims or his achievements.

As I have said, I think it would be agreed now that the central Angle doctrine is not tenable. What has taken its place? I think the answer is quite clear, that nothing has taken its place. The questions I framed earlier in my talk as arising out of the implications of the Angle doctrine are still without agreed, or even sectionally accepted, answers. Almost one might say that we are back to the situation of European Orthodontics of my earlier days, with each practitioner approaching individual cases by the light of general knowledge. If you look through a work such as Salzman's " Principles of Orthodontics," still more if you review periodical literature, you realize that the biological sciences have been pretty thoroughly ransacked for any bits and pieces that might throw light on our subject, but that it is by no means sure that much of it is really relevant to practice. And you will find that some considerable progress has been made in collecting data on which to base a science of facial development; and that individuals have attempted to state doctrines about limited parts of the field of orthodontics, but that of these none has gained general or even very wide acceptance. The position is apparently chaotic, but in my view it is really a healthy one, as reflecting the realities of our stage of development as a science. Before we can generalize we need a great deal more proved data on which to base our generalizations. And in particular we need to solve the problems of defining the categories to which our generalizations refer.

But if our state of development is such that interchange of exact views between orthodontists on clinical cases, except as individual cases, is almost impossible there does seem to me to have grown up in recent years a common approach clinically to the problems of orthodontics. And if I proceed mainly on inference from what orthodontists do I think I can put that common approach into a form of words which has the greater chance of approximating the truth because it deliberately avoids precision.

As I see it, then, the experienced orthodontist takes a dual view of his field of operation. The dentition—teeth and alveolar bone—he looks on as a sort of embodiment of a pressure system which is in a state of precarious and perhaps temporary equilibrium. Such margin of stability as it may have is due to the height of the threshold of bone response to pressure. In that part of his field he thinks, and it is appropriate to think, mainly in terms of mechanics. And that is so not merely in matters of treatment, which he can only carry out by introducing a new pressure element. It is true also in judging how the present equilibrium was reached. Even where bio-chemical stimuli have presumably

operated, as in eruption of teeth, their effect has been transformed, owing to the relatively crowded state of all human teeth, into pressure factors. And it is true in estimating the outcome of treatment. That outcome depends on the establishment of a new equilibrium with a new arrangement of the teeth, and the conditions of stability have to be thought out primarily in terms of pressure.

But there is another part of the orthodontic field in which he finds a different form of thinking appropriate. The dentition is held and operated between two parts of the face which, though they contribute something to the pressure system are themselves almost independent of it. Thinking in that part of the field is necessarily mainly in biological terms because the factors which govern it are mainly biological. A great deal of the difficulties of the past have I think arisen through allowing theory appropriate to one of those parts of our field to wander over into the other. The separation can never be absolute. It is an abstraction for purposes of analysis, but I believe that use of that abstraction will be of great assistance in clarifying thought and the expression of it.

If what I have had to say about the past has any meaning for the future it is surely this, that education plays a decisive part in determining the mode of development of practice. Looking at short periods of time you hardly discern that, but when you review a stretch of even 30 years you can see that education conditions practice as surely as economics does. If one who has set out to talk of orthodontics in his time may claim that some fraction of the future belongs to his time I would like to say a little about orthodontic education in the future. Mainly, the lesson that emerges for me from my review of the past is that orthodontics needs a broad basis for its education. In practice the orthodontist must think in terms of both the physical and the biological sciences, and he will not do that effectively unless he has thorough grounding in them. In concrete terms, that means that I regard a B.Sc. as the best foundation for the study of orthodontics.

In specifically orthodontic teaching the significant fact seems to me to be that we are not yet in a position to teach at all, because we have no coherent body of doctrine by which we who have much experience can pass on to those who have little the lessons we have learnt. While we can often say with fair assurance, "*This case* arose in this way, and this line of treatment will produce a stable result," we cannot over any substantial range pin down for students the group to which *this case* belongs. He will never meet *this case* again, but he will meet others which have some similar features and some dissimilar. We cannot in general give him a valid formula which will enable him to distinguish the essential characteristics which are evidence of common origin and common treatment-needs from the similarities which are incidental. So that when we air our theories for the student they are either theories "in the air" or theories which appear to be invalid because applied to the wrong cases. Simon and Tweed have defined groups in terms of measurable planes and angles, and that method may develop further in conjunction with the elucidation of facial development on the Broadbent technique. It seems to me more probable that the most useful means of defining groups will be found rather through the descriptions of associations of general symptoms with occlusal conditions. But that, if it arrives, is still some distance ahead. Meantime the fact remains that as teachers we can give our students a considerable range of information about tooth behaviour in various circumstances — applied dental anatomy; and that we can discipline them in that basis of all diagnosis, systematic noting

of everything that is to be seen in the individual case; but that we open our mouths on doctrine at peril of misleading them. Our practice tends to be a great deal better than our theoretical account of it, and while it is a counsel of perfection that we should refrain from theorising we can at least give the student of orthodontics the opportunity of sorting out the gold of our practice from the dross of our theory. That is a slow process. It involves return to the apprenticeship system, now to be called the Registrarship system, as the basis of post-graduate training in orthodontics. Short courses and diploma examinations seem to me inappropriate until such time as orthodontic teachers and examiners have some common body of orthodontic doctrine.

Obliteration of the pulp of a permanent incisor at the age of 13-9/12 years

By K. Corisande Smyth, f.d.s., r.c.s.

This very short communication is a small contribution to the study of that troublesome complication of orthodontic treatment which is so frequently encountered—damage sustained by permanent incisors due to injury.

Such damage may be obvious at the time of injury, either clinically,—if there is a fracture in the crown of the tooth,—or radiographically, if there is a fracture of the root. There may be displacement and/or loosening of the tooth, with or without fracture. In such cases advice is usually sought at the time from a dental surgeon and the damaged tooth protected as far as possible from further injury, also kept under observation, so that there are plenty of case histories of this type available.

But there are many cases where the injury does not cause any obvious damage at the time, and if symptoms arise later on, the earlier history is often difficult to elicit.

This is a case where the first sign of trouble arose at the age of 13 years 1 month when pain was complained of in 1| when hot or cold drinks were taken. At this stage, the active orthodontic treatment had been completed a year before, having included retraction of the central incisors by means of a labial arch which had never at any time been allowed to exert excessive pressure. Retention had been effected by the wearing of an oral screen (required also to correct mouth-breathing) during the last year.

As the patient was at this time only attending at intervals of six months in order to check the permanence of the result and the condition of the gingivæ, he was instructed to be sure to report any increase or even continuance of these symptoms to his dental surgeon. Apparently the symptoms decreased, and no further complaint was made. When seen for his orthodontic check-up in September, 1949, aged 13-9/12, I noticed—in a particularly good light,—a slight darkening of 1|, and detected also a very slight looseness. This was reported to his

Short Communication presented to the meeting on 13th February

dental surgeon, and an X-ray was taken.

The slide shows the condition of the root, in which the pulp chamber appears to be completely calcified. Application of heat and cold at this time to the right central gave marked reaction, to the left central only very slight sensation after ½—1 minute of application.

Upon close enquiry, the patient was able to remember an incident when he was seven years old, when he was hit in the mouth by a tennis ball, which hurt him very much—he remembers yelling! Not more than a year later he received a football in his face and was "knocked out."

At seven years of age there would be an open apex, and the kink in the root could have been caused by the first blow, which did not kill the pulp quickly. Possibly the later blow hastened the gradual deterioration of the pulp, but it seems strange that there was an access of sensitivity at 13 years of age, by which time the process of calcification must have been well advanced, to judge from the condition shown in the X-ray only seven months later.

The orthodontic treatment is not stressed in this case, as there appears to be no connection between it and the condition of the injured incisor. Both central incisors were prominent, accounting for the blows being received on them, but treatment was entirely normal and uneventful, and the result is only indicated in one photograph to show that there is perfect alignment without any residual closeness of the bite.

Am I right in thinking it is very unusual to see such extensive obliteration of the pulp chamber in a patient of under 14 years; has any member seen calcification of the pulp of a growing tooth following a blow?

I am indebted to Mr. T. C. Stretton for allowing me to incorporate his own observations of this case, which he referred to me for orthodontic treatment only.

Discussion

Mr. H. Chapman said that he had seen one case of a similar nature to that desscribed by Miss Smyth. He first saw the patient at the age of 9 years and 10 months, and he did not recall anything being wrong with her upper central incisors at that time. At the age of 11, she tripped and knocked her chin, causing the upper front teeth to be tender. When she was 13 years and 3 months he noticed that the right upper central was turning slightly brown, and its response to a thermal test was much slower than in the case of the other central. He saw the patient again at the age of 17 years 6 months; the right upper central looked just the same, slightly browner than the other teeth, but he did not test it at that time. The patient's mother told him that the dentist said the pulp was nine-tenths alive, but he doubted whether she had understood the dentist aright, because his recollection was that the response was much slower than it would have been in that case. The tooth was apparently becoming calcified to a great extent. He was sorry that he had no more details to give of the case or any X-rays to show of it.

Three Cases of an Unerupted Deciduous Molar

By W. J. Tulley, B.D.S., L.D.S.

Case 1

Figs. 1 *and* 2 show the models and dental radiographs of a girl aged $4\frac{1}{2}$ years who presented with the lower left second deciduous molar missing from the arch, and there was no history of extraction.

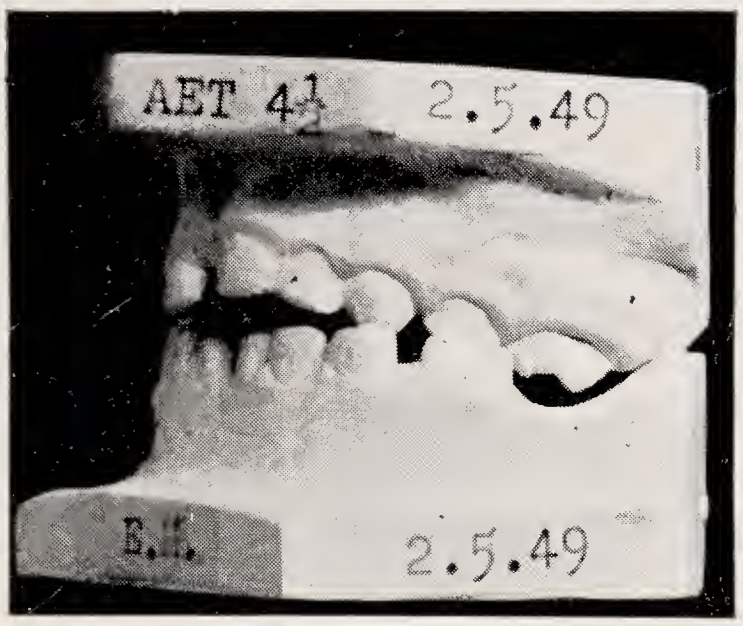

FIGURE 1

FIGURE 2

Apart from this the case was full of orthodontic problems, there being an anterior open bite, marked spacing of the upper deciduous incisors and linguo-occlusion of the cheek teeth on the left side.

The missing tooth could not be palpated in the alveolus. On X-ray examination, the deciduous molar was seen low in the

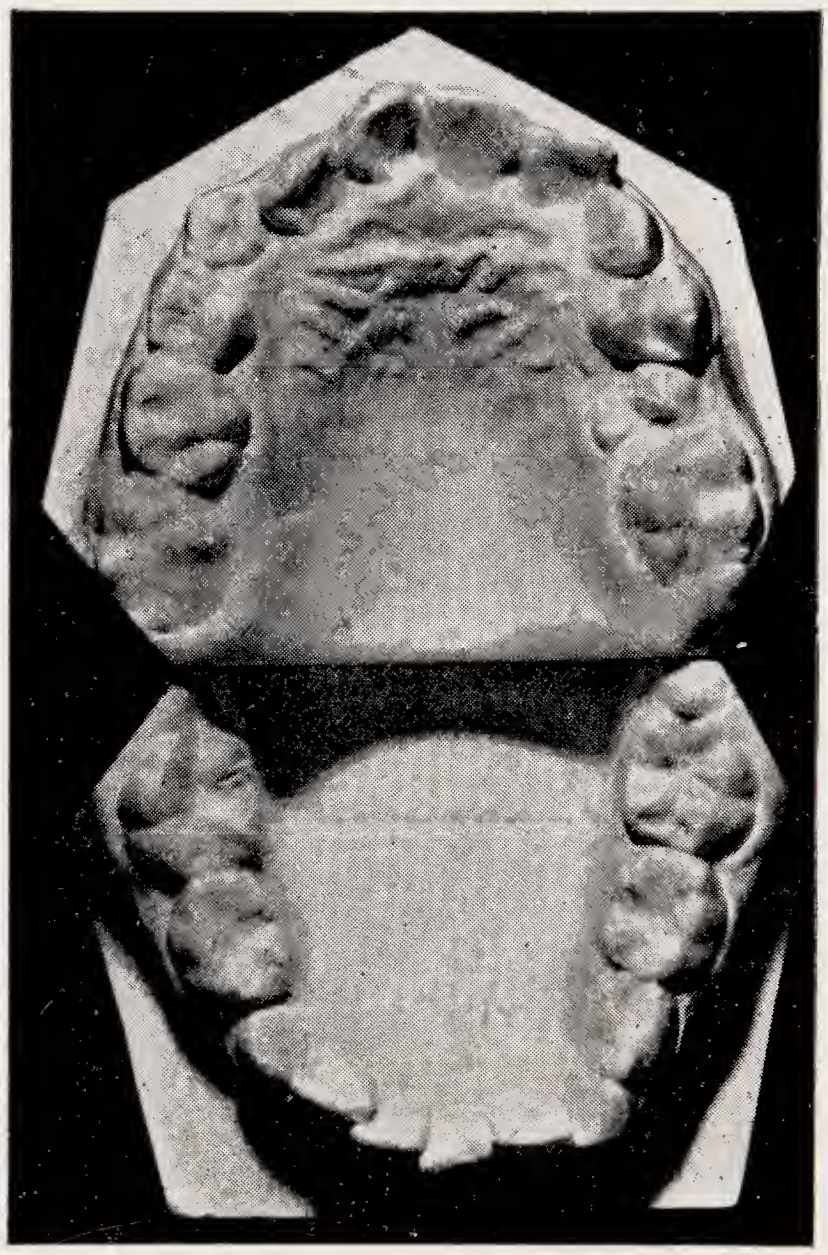

FIGURE 3

Short Communication presented to the meeting on 13th February

recurved in close proximity to the inferior dental canal. Surrounding the crown of body of the mandible with its roots the tooth there was a rarified area of bone fairly well circumscribed, and a small denticle with a degree of calcification equal to that of the second premolar of the opposite side.

FIGURE 4

Clinically, there was no expansion of bone and no palpable cystic condition.

At operation the denticle and the deciduous molar were removed. It was necessary to cut the tooth in two and remove a considerable amount of bone from the buccal aspect. The rarefaction of the bone was not nearly so marked as the radiograph led one to suppose.

It would appear that the denticle was a supernumerary of the deciduous dentition which had prevented the eruption of the deciduous molar with consequent degeneration of the remnants of the enamel epithelium. If the deciduous molar had not been removed the condition would have almost certainly progressed to form a true dentigerous cyst.

Case 2

Figure 3 shows the models of a girl aged $10\frac{1}{2}$ years who presented for orthodontic treatment with crowding in both arches. The lower right first deciduous molar was missing from the arch and was at first thought to have been extracted.

FIGURE 5

FIGURE 6

X-ray examination revealed the deciduous molar to be present and low in the body of the mandible (*Fig.* 4). The first premolar was present and erupting lingually.

More recent radiographs show the first premolar to have moved to occupy a position above the deciduous molar and its crown was bulging the mucuous membrane on the buccal aspect. (*Fig.* 5).

At operation both the premolar and deciduous molar were removed, there being no room in the arch for the premolar.

Case 3

Figure 6 shows the models of a patient aged $12\frac{1}{2}$ years who presented with the upper right first permanent molar impacted against the first premolar with the second premolar erupting into the palate. (*Fig.* 7).

On X-ray examination the faint shadow of a deciduous molar could be seen on a level with the apices of the first molar.

At operation the first molar was extracted and the remains of the deciduous molar from where it was lying just beneath the floor of the antrum, all that remained was a shell of enamel.

The treatment consisted of holding back the second molar on eruption and guiding the second premolar into the arch.

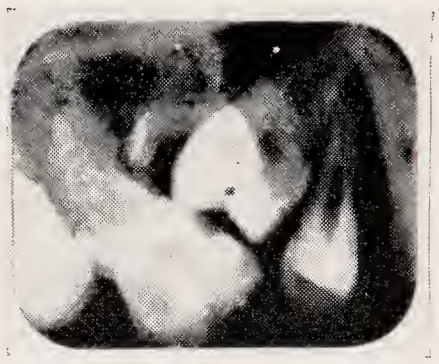

FIGURE 7

In looking for similar references I have found few* where the premolars have made such an effort to erupt as in the second case. I feel it will be a long time before we fully understand the mechanisms of tooth eruption.

My thanks are due to Mr. Rix and Mr. Pringle for permission to report these cases which are under their care at Guy's, and to Mrs. Small of the Photographic Department and Miss Coales, Secretary in the Dental Department for Children for help in preparation.

**British Dental Journal.* Vol. XLVII, No. 16. *Journal of American Dental Society.* Vol. XXVIII, No. 5.

Discussion

Mr. H. G. Watkin said that he was very interested in Mr. Tulley's communication. He thought the moral to be drawn from it was that X-rays should always be taken if any teeth did not erupt at the time when they should do so.

Mr. L. Russell Marsh congratulated Mr. Tulley on his very fine presentation of three interesting cases and on the magnificent X-rays, which were, he thought, an an example to all orthodontists.

Mr. D. F. Glass asked for what reason Mr. Tulley stated, in showing the last slide, that the E was absorbed. By what agent was it absorbed? The enamel was still there and the roots appeared to be there, but the dentine was absorbed. If there was a connection with the exterior surely the enamel would remain but the dentine would be removed by caries. What were Mr. Tulley's views on the absence of dentine and the presence of enamel ?

Mr. H. Chapman said that he was very interested in the case in which the premolar escaped from below the deciduous molar. Its change of position was very remarkable. He recalled seeing a similar case, in which a second premolar escaped from below a second lower deciduous molar and erupted behind it, after having been at age 8-1 directly below $\overline{|E}$ which was in normal occlusion. At age 8-6 $\overline{|6}$ was extracted at 10-3 $\overline{|5}$ is entirely distal to $\overline{|E}$ and moving occlusally.

Mr. W. J. Tulley thanked Mr. Watkin and Mr. Russell Marsh for their remarks and said that he owed a debt of gratitude to the X-ray department of Guy's Hospital. He had not taken the films himself, and he thought that a great deal depended on the excellent preparation by the photographic department.

In regard to Mr. Glass's questions about the absorption, perhaps "absorption" was not the right word to use. He had a little doubt about whether the tooth in question, although it was very deep, had not been in the series at one time, because the deciduous molar on the opposite side was submerged below the level of occlusion, but he thought it was a little too deep for that. It might be that the dentine, containing more organic material than the enamel, had been eroded by osteoclastic activity, as the roots were normally absorbed, so that the dentine of the crown was also absorbed, but he would not like to offer any suggestions on that point.

With regard to Mr. Chapman's remarks, he had found references to two similar cases of the escape of a premolar from an unerupted deciduous molar. The refererences were the *British Dental Journal*, Vol. 47. No. 16, and the *Journal of the American Dental Society*, Vol. 28, No. 5.

Aetiological Approach to Orthodontic Diagnosis

By J. H. Hovell, f.d.s., l.r.c.p., m.r.c.s.

In the field of general medicine, though there have been many instances of satisfactory treatment of a purely empirical nature, in the main, treatment has evolved through a knowledge, first, of the normal physiology of the affected part, and then of the pathology and ætiology of the abnormal condition.

For many years, up to the last war, treatment of malocclusion has been, in the main part, empirical, resulting in many failures, and, what was worse, a complete lack of understanding as to why some cases went well, and others failed to respond, or subsequently relapsed.

I wish to emphasize, in giving my views this evening, that they are in no way original, but based entirely upon the research work of others. In particular, I am indebted to Ballard, Gwynne-Evans and Rix, in this country, and Broadbent, Gesell, Margolis and Stockard in America. As a result of the work of these men, a new school of thought, and a logical approach to the subject, is now arising in this country.

Before proceeding to pathology and ætiology, a few words must be said regarding the physiology of the production of normal occlusion of the teeth. The classic work of Friel upon the mechanics of the production of normal occlusion, is known to us all, but we must go a step further, and ask ourselves why the teeth actually start in the positions in which they are found on eruption, and why the various changes which take place subsequent to eruption, actually occur.

To my mind, the factors involved are almost entirely genetic in character. First, the relationship of the jaws to each other, or, if you prefer it, of the upper apical base to the lower apical base. In the antero-posterior and lateral directions, the predetermined size and form of the jaws produces this relationship. In the vertical plane, there are two positions of the mandible which have to be considered —the resting position with the teeth apart, and the closed position with the teeth in centric occlusion. The former is brought about by the tonic rest position of the muscles of mastication; the latter, by the sudden relaxation of the elevators which occurs when centric occlusion is reached during mastication. It is this sudden relaxation which produces the position of centric occlusion, not the position of centric occlusion which produces the relaxation. Both these are hereditary characteristics of muscle.

Next, the position of the developing unerupted teeth in the jaws. This is genetically determined, and is such that, if the bone relationships are normal, and the crowns were influenced by any other factors, the deciduous cheek teeth would erupt into normal occlusion as described by Friel, the roots remaining in their normal relationship to the apical bases.

There is however, another factor which influences the positions of the crowns of the teeth as soon as they have pierced the gum, and which, in the case of normal bone relationship, is entirely responsible for normal dental relationship in the bucco-

Paper presented to the meeting on 13th February.

lingual and labio-lingual directions. This is, normal tone, posture and function of the muscles of the lips, cheeks and tongue. The lower incisors erupting in a retroclined position, are moved labially until they reach that area where the tonic forces of lips and tongue are equal, and thus erupt into correct occlusion with the upper incisors coming down in the same area.

The tonus of these muscles is of genetic origin, and it would seem probable that many faulty postures and behaviour patterns are also inherited. There is yet another factor that influences the positions of the crowns of the teeth. This time, not within the bucco-lingual and labio-lingual directions, but in the longitudal directions of the apical base. This is the relationship of the size of the teeth to the size of the apical bases, both genetically determined. The size of the teeth cannot be changed; but whereas it may be possible for illness, or even lack of function, though I doubt this, to reduce the size of the jaws, nothing will make them grow larger than their genetically determined optimum size—certainly not orthodontic treatment. I except here of course, gross pathology, such as endocrine disorder. Nor is the actual skeletal pattern and jaw relationship altered by reduction in growth, these remain entirely unchanged. This is why the old conception of the advancement of the mandible in the treatment of post-normal cases has now been completely abandoned. This would involve both an increase in size and a change in form of one of the bones of the body by purely mechanical means. Stockard, in his work on the inheritance of skeletal patterns in dogs says:— "Structural disharmonies closely similar to those under discussion are very common in the faces of human beings. There are faces of narrow, wedged, sharp type and wide flat type with very distinct differences in patterns for the two jaws, and a careful observer may commonly see the hybrid combinations of these jaw patterns. Orthodontists are constantly attempting to correct the dental malocclusion of children with the overshot condition or maxillary prognathism, and people are continually losing their teeth because of malocclusion due to the undershot prognathous mandible. The overshot prognathous upper jaw is very common and very disfiguring, and the undershot jaw associated with a somewhat flat upper face is met with in every community. There is little doubt that these disharmonies can be registered among those ills resulting from type and racial hybridization."

We all know how easy it is to move teeth through the bone, with the lightest of forces, and I am amazed that in the past, orthodontists, myself included, should have believed that an intermaxillary traction appliance attached to the teeth, should have increased the size and altered the form of the jaws, and not as we now know, merely moved the teeth. This in spite of the fact that in this country we were bitterly opposed to the American concept of thirty-two perfect teeth in a perfect arch, and to the use of expansion either antero-posterior, lateral, or both, as a universal panacea for all orthodontic ills.

To come back to the relationship of tooth size to apical base, for normal, or perhaps I should say, "ideal" occlusion to develop, this relationship must be normal. If this is not so, certain malocclusions will develop along the line of the apical bases. As growth proceeds, the downward, outward and forward growth of the upper alveolar process, and the upward, outward and forward growth of the lower alveolar process, carry both dental arches forward, the lower slightly faster than the upper, a change in dental arch relationship which is facilitated by attrition of the deciduous teeth. Finally, on the replacement of all the deciduous by permanent teeth, normal adult arch relationship is established.

When the deciduous are replaced by

the permanent incisors, the latter erupt in a more proclined position. This is because the muscles developing concomitantly with the jaws, first move the crowns of the deciduous teeth into a larger arc of a larger circle, producing spacing, and similarly guide the crowns of the erupting teeth into this position which gives the necessary space for the larger permanent teeth. I would like to stress that it is growth and development of the muscles of the lips and tongue occurring at the same time as that of the bone, which plays an important part in the spacing, and is completely responsible for the alignment of the incisors in the normal case.

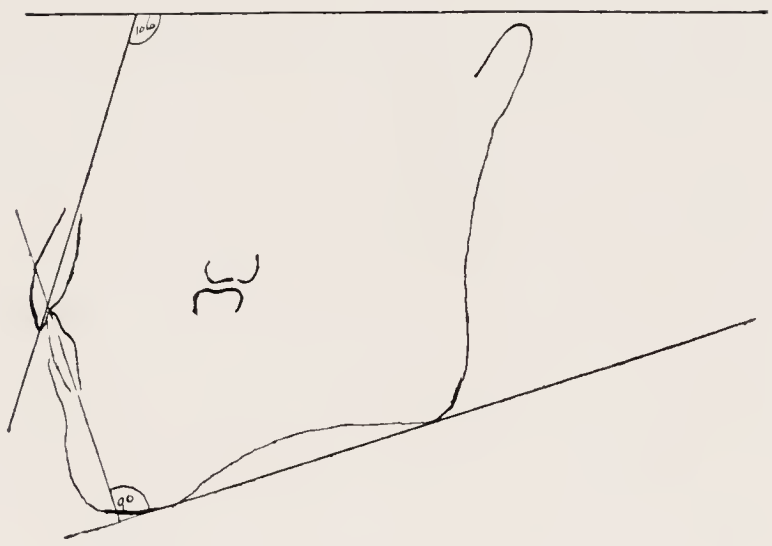

FIGURE 1

Tracing showing normal incisor and molar relationship and normal apical base relationship.
Top angle 106°, bottom angle 90°.

It has been shown by Margolis and others, that the normal relationship of lower incisors to the mandibular plane is within a few degrees of a right angle, and of the upper incisors to the Frankfort plane, about 105-110 degrees. These angles vary according to the Frankfort mandibular angle (normal 16-24 degrees) to give a relationship of upper to lower incisors of from 135-140 degrees. These angles are such that during mastication, three point contact is maintained, and no unduly heavy strains are borne by the incisor teeth—most important from the point of view of the health and continuance of normal function of the parodontal structures.

Therefore, in viewing any malocclusion the following all important facts must be borne in mind.

1. That the crowns of the teeth in a bucco-lingual and labio-lingual direction are in a position of equilibrium within the oral musculature. It follows that they can only be moved into a fresh position in these directions if the muscle pattern can be altered, or is likely to alter naturally in such a way as to retain them in this fresh position.
2. That the apical bases have a genetically fixed and unalterable relationship to each other. They can be regarded as troughs along which it is possible to move the apices of the teeth, but across which this is impossible.
3. That the relationship of size of apical base to size of teeth is constant and unalterable, other than adversely by reduction in size of apical base by disease.

Having postulated these basic principles, I will now examine varying types of malocclusion and show how diagnosis of the ætiology points invariably to the correct line of treatment and the prognosis of the case.

First, malocclusions which may be produced entirely by faulty muscle posture or behaviour. Of this, by far the most common is proclined upper incisor teeth. This is due entirely to a faulty muscle posture—that which used to be known as the atonic upper lip. The lip is not atonic, it may have, in fact, probably has a normal tonus, but at rest, occupies an abnormal position with absence of lip seal. This is a persistent infantile neuromusculature pattern, and as a result of this faulty posture, the pressure on the labial surface of the upper incisors is reduced, or absent, and they consequently erupt in a proclined position. To make matters worse, the lower lip gets underneath them, and reinforcing the pressure from the tongue, still further increases their labioclination, sometimes to such an

extent that the lips cannot be brought together, even with an extreme effort. Secondarily to the lower lip getting between the upper and lower incisors, the latter are often retroclined.

The prognosis in the treatment of such a case depends upon whether it is possible to produce a normal posture in the labial musculature. Fortunately, this is seldom any problem, because persistent infantile neuromuscular patterns tend to mature of their own accord into normal patterns, particularly as the child approaches adolescence. That is why, though many children are seen with exposed upper incisors with the muscles in rest position, this is seen far less often in adults. It must also be remembered that mouth breathing is not necessarily associated with an infantile lip posture, and also a small percentage of children with faulty lip seal are also mouth breathers. Similarly, a mouth breather does not necessarily have a faulty lip posture. I have seen cases of mouth breathing with complete nasal stenosis, in which, owing to correct posture and oro-labial muscle function, the arches and the incisor relationship were normal.

To revert to prognosis, the natural tendency towards the development of the normal posture in these cases, is thwarted by the abnormal position of the teeth produced by the posture. Correction of the malocclusion is, therefore, the first necessity, and with this done, lip posture matures and then retains the teeth in normal position. The prognosis is, therefore, excellent.

Next we come to faulty swallows and tongue postures. There are many of these which produce varying malocclusions, according to their nature. Probably the commonest we meet with is, the closed bite swallow with a tongue thrust. The tongue is pushed between the incisor teeth during swallowing, and produces an anterior open bite, by preventing them from erupting into occlusion. This may be the primary cause of such a malocclusion, or it may have been subsequent to an old thumb sucking habit. When an anterior open bite has been produced by thumb sucking, the tongue, unused to working in a closed cavity, is thrust into this space during swallowing, and may perpetuate the open bite after the thumb sucking habit has been given up.

Also frequently seen, is the persistent infantile teeth apart swallow, in which the tongue oozes out, not only between the incisors, but also between the cheek teeth, and lies there when at rest, producing an infraclusion in this area also.

Regarding treatment, again, first cure the dental deformity produced. It may be simpler in the case of the open bite deformity to give the child an appliance to wear which will provide a closed cavity in which to move the tongue when swallowing and, at the same time, will allow the incisors to erupt into normal relationship. A monobloc does this, but I think that in these cases, it should be worn not at night only, but as much as possible during the day. Exercises of varying types may also be of use. To discuss this subject fully demands a paper in itself, which would be better delivered by an authority on oro-facial muscle function, such as Ballard or Rix.

I think it is time now to go into the ætiology of the production of what may be described as our National Deformity —Angle Class 2, Div. 1 malocclusion. This malocclusion is not most commonly due to a faulty antero-posterior apical base mal-relationship, though it may be accompanied by such. There are two factors in its causation:— persistent infantile lip posture and mal-relation of size of upper teeth to upper apical base; i.e., either the teeth are too large for the bone, or the bone too small for the teeth. In this connection, it is to be noted that when there is a reduction in size of apical bases, it is almost invariably the upper which suffers most. There may in fact,

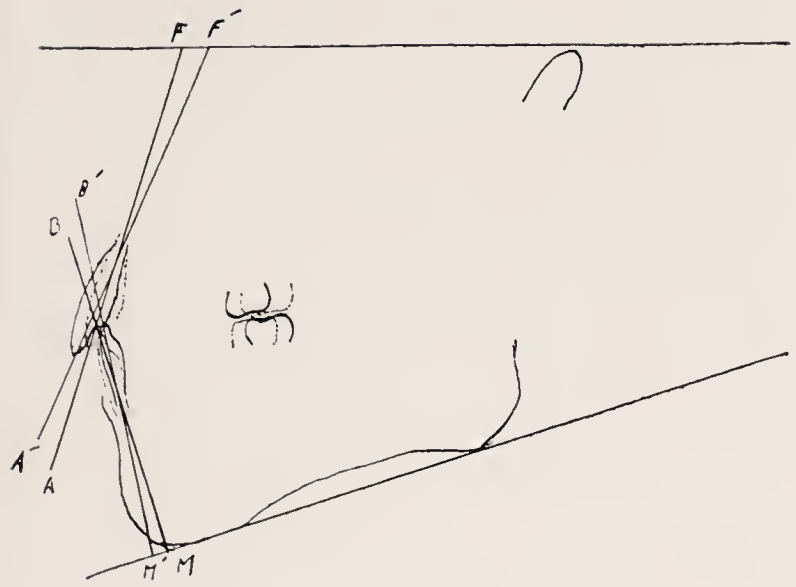

FIGURE 2

Tracing to demonstrate development of Class 2' Division 1 malocclusion without change in apical base relationship. Dotted lines show normal incisor and molar relationships. Continuous lines show proclined upper incisors and retroclined lowers with forward drift of upper molars and holding back of lowers. The skeletal pattern is normal.

be considerable reduction in the size of the upper apical base, with no reduction of the lower at all.

How then, is this deformity produced by these factors? I have already shown how the upper incisors procline and the lowers retrocline owing to the faulty lip posture. It is the reduction in size of apical base, plus the lack of interproximal contact with the upper incisors and canines, which produces the faulty arch relationship.

This mal-relation of apical base to dental tissue, maintains a constant proportion during development, and each cheek tooth when it erupts, starting with the upper canine, tends to be moved forward by pressure from its developing successor, unrestrained by interproximal contact with the incisors and lip pressure. If the degree of disproportion is, say 15%, the canine will move forward 15% of its width. When the deciduous molars have erupted, the entire upper buccal segment will have moved forward by 15% of its total antero-posterior coronal dimension, and by the time the first permanent molar erupts, this forward drift will be practically equivalent to the width of one premolar tooth, i.e., one unit. Further antero-posterior malrelationship is brought about by the pressure of the lower lip between upper and lower incisors. This not only retroclines the lower incisors, but also holds back the entire lower dental arch from its normal forward development. The proportion in which forward drift of upper buccal segments and holding back of lower dental arch contribute to the antero-posterior mal-relation, varies in different cases, and can only be decided by cephalometric analysis.

As the crowns of the upper cheek teeth move forward, the teeth tend, at first, to tilt. Occlusal forces may later upright them, causing the apices also to move forward, but often the interference with occlusion produced by their movement is such, that they remain permanently in a tilted condition. This is frequently seen in a Class 2, division 1 case. Owing to their proclination, the upper incisors and canines lose contact with the tongue, and the upper arch consequently becomes V-shaped. The incisor relationship being disturbed, the lowers over-erupt, until they meet either the cingula of the uppers, or perhaps even the anterior part of the palate. Thus are all the typical features of a Class 2, division 1 malocclusion produced with a normal apical base relationship.

Treatment and Prognosis

In such a case, treatment is simple, prognosis excellent. It has already been seen how, superior proclination with normal arch relationship, corrected incisor position is maintained by maturation of lip posture. The same applies to these cases, but it is necessary in order to move upper incisors and canines to their normal inclinations, either to move back the upper buccal segments, or to remove upper first premolars. If it is decided to move back the upper buccal segments, tooth tissue must be reduced to eliminate the cause of the forward drift, unless upper

wisdom teeth are congenitally absent, upper second molars being the teeth of choice. Again, time does not permit discussion of when to remove the upper second molars, or when to remove the upper first premolars; there are, however, definite indications, such as degree of forward drift of upper, and holding back of lower; and axial inclinations of upper cheek teeth, which are quite decisive in determining which teeth to remove.

This malocclusion can still be produced in the same way when the lower apical base is actually placed mesially to the upper. That is to say, the skeletal pattern may be Class 3 with the mandible too far forward, while the dental relationship is Class 2, division 1. When the apical base relationship is postnormal, the cheek teeth erupt into postnormal relationship with each other, even though there may be no forward drift of upper teeth, and a Class 2, division 1 occlusion can develop in this case, without reduction in size of upper apical base.

When apical base relationship is post-normal and lip posture normal, the type of case described by Miss Smyth as Class 2 intermediate, with postnormal arch relationship, normally inclined upper incisors and increased incisor overlap will be the result.

With an abnormal apical base relationship, normal incisor relationship can never be obtained, and gross alteration from normal axial inclination of the cheek teeth may be necessary to obtain a " normal " antero-posterior relationship. In fact, if the skeletal pattern is post-normal to the extent of one dental unit, the normal occlusion of the cheek teeth is in post-normal relationship, as this leaves them in normal axial inclination to the apical bases. This of course, contra-indicates extraction of the upper second molars, and backward movement of upper buccal segments. The prognosis in such cases varies according to the degree of apical base mal-relationship, as firstly, it is not possible to obtain a normal incisor relationship, and secondarily, the mechanical interference by the faulty skeletal pattern may, if severe, prevent maturation of normal lip posture.

One form of faulty incisor relationship which may be produced by faulty muscle function, anterior open bite, has already been mentioned. I will now show how the converse, excessive incisor overlap, which I have already touched upon, fits into the pattern. Previously called " Close Bite," it used to be thought that it was due to a decrease in the intermaxillary space, and treatment was aimed towards increasing this, accompanied by frequent discussions as to whether a " bite plate " caused elevation of the cheek teeth, or depression of the lower incisors. It is now known that the intermaxillary space has nothing to do with excessive incisor overlap, but this is due to a faulty incisor relationship, which may be produced in a variety of ways, plus the fact that unopposed teeth continue to erupt until they meet something which arrests this process.

Normal incisor relationship is such that about one quarter to one third of the anatomical crowns of the lower incisors is overlapped by the crowns of the uppers, and the long axes of these teeth are at an angle of 135 degrees to 140 degrees to each other. This is the relationship produced when the apical bases are normally related to each other, in an antero-posterior direction, the oro-facial musculature and Frankfort mandibular angle normal, and the dental arches are intact. The excessive incisor overlap arising from an early loss of lower deciduous teeth, or first permanent molars, is easily seen to be due to the effect of the loss of these teeth upon the incisor relationship, and not to an alteration of the intermaxillary relation. Sometimes, loss of these teeth causes no alteration in the position of the remaining teeth. This is the case when the skeletal structure and

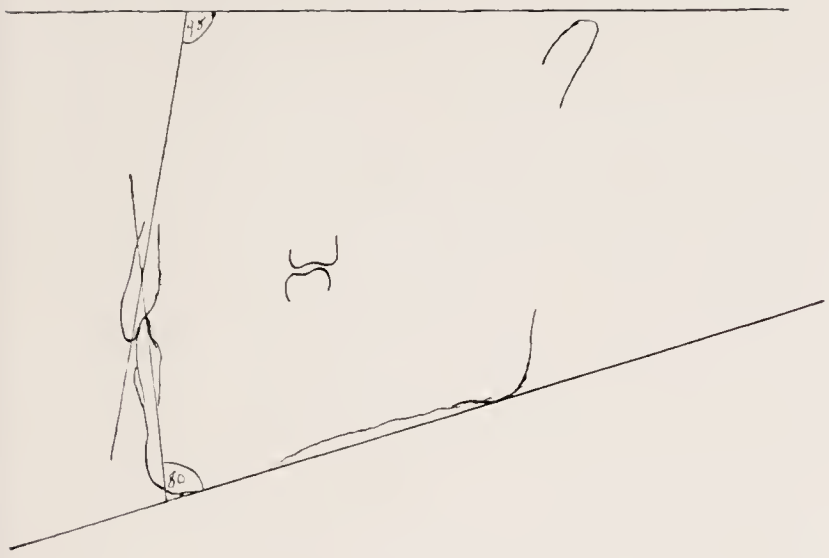

FIGURE 3

"Mershon" true close bite. Retroclined upper and lower incisors due to hypertonic lip posture and consequent excessive incisor overlap.
Top angle 98°, bottom angle 80°.

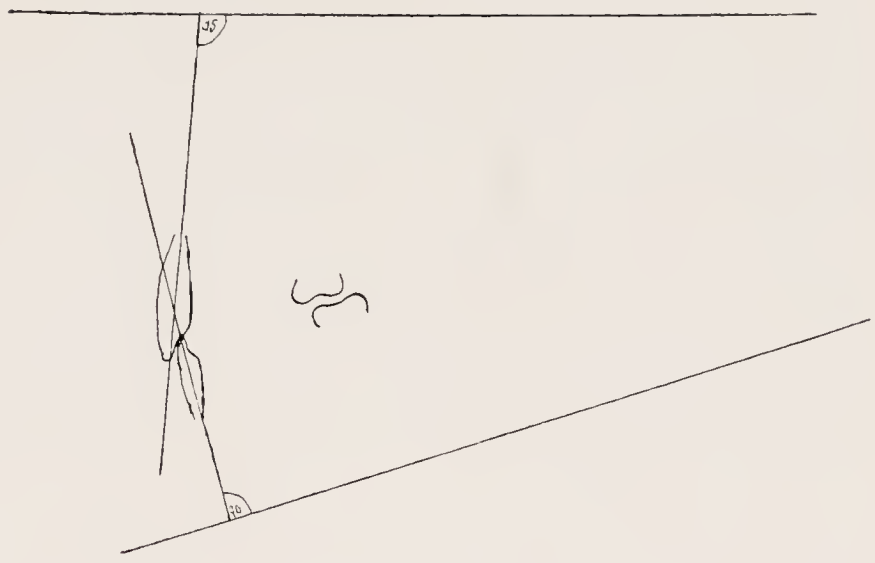

FIGURE 4

Class 2 Division 2 with retroclined upper incisors. normal lower incisors and a post normal skeletal pattern. Aetiology: hypertonic lip posture plus post normal apical base relationship.
Top angle 95°, bottom angle 90°.

its associated musculature is normal in size, or even larger in proportion to the dental tissue which has to be accommodated. In the Anglo-Saxon races, this is seldom the case, and the loss is usually followed by a tilting forward of the cheek teeth behind the space, and a backward tilting of the teeth anterior to it. The lower arch is, of course, growing forward all the time, so that what actually occurs is that the apices of the anterior teeth are carried forward, but the crowns lag behind, which appears on models as a backward tilting of these teeth, the actual growth in size of the lower apical base being quite unaffected. The incisive edges of the lower incisors are, therefore, placed distally to their normal positions in relation to the upper incisors, and consesequently, continue to erupt until occlusual contact is established further palatally than normal with the upper incisors, an excessive incisor overlap being thus produced. Muscle action alone is responsible for that type of faulty relationship originally described by Mershon as a "True Close Bite." Here a hypertonic musculature—i.e., a musculature in which the posture is normal, but the tonus abnormal, causes both upper and lower incisors to become retroclined, with the result that normal occlusal relationship cannot be established, and the lower incisors over erupt. This type of faulty incisor relationship can sometimes be treated by proclination of both upper and lower incisors to correct relationship, though in severe cases, the lip pressure is so great that the posterior teeth will move backwards, and the incisors remain retroclined. Cases treated successfully however, will inevitably relapse, as the cause of malocclusion, the hypertonic is not, to my knowledge, capable of being altered. Some authorities do not agree that this is a muscle hypertonicity, but consider it also a faulty posture, saying that they do not see how one group of muscles can have a different tonicity from others in the body. I see no physiological or genetic reason against this. Firstly, Stockard has shown that size and form of two such closely related bones as upper and lower jaws can be inherited entirely separately. Secondly, the muscles concerned have an entirely different function from the skeletal muscles, so why not separate inheritance of degree of tonicity? Thirdly, these muscles are their own antagonists within the structure of the lips and cheeks, so any alteration in their tonus will alter the degree of pressure upon the labial surfaces of the incisors, whose positions accordingly vary with the muscle tonus. The position of

the lips of course, is also affected, but we are dealing here with a faulty position, of which abnormal tonus is, I think, the primary cause. I prefer therefore, to class double retroclination or proclination of incisors as due to abnormal (genetically determined) oro-labial muscle tonus and not to the change of posture which accompanies and is the result of this abnormal tonus.

It is indeed possible to have a faulty posture with a normal or abnormal tonus. Thus when the persistent infantile lip posture matures after correction of the dental malocclusion it has produced, it may assume a normal posture with normal lip seal and either normal hypo or hypertonicity. I have seen excessive incisor overlap arise after treatment of an Angle Class 2 Division 1 owing to upper and lower incisors being retroclined by a hypertonic labial musculature on its maturation.

Persistent infantile lip posture will also cause a typical faulty incisor relationship. The upper incisors deprived of labial pressure, procline, and the lower lip coming between upper and lower incisors, the latter frequently become retroclined, erupting until they obtain contact either with the cingula of the upper incisors, or even with the palatal mucous membrane.

A post normal skeletal pattern with the lower apical base distally related to the upper, will effect the incisor relationship. Normal muscle action influences the crowns to erupt into normal relationship, but frequently cannot overcome the apical base mal-relation, so again, the lower incisor is placed distally to its normal relation with the upper, and an excessive overlap occurs, and an Angle Class 2 mal-relation is produced, with normally inclined upper incisors. Combination of a post-normal skeletal pattern, with faulty lip posture or tonus, will increase the malocclusion produced by the latter. For example, the Mershon true close bite,

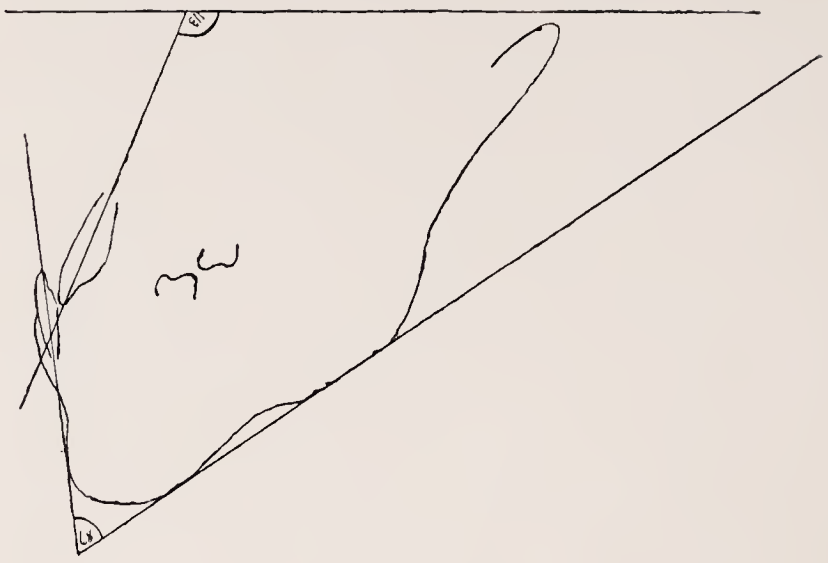

FIGURE 5

Class 3 with very poor prenormal skeletal pattern. The attempts of the lips and tongue to bring the incisors into normal relationship are shown by the grossly retroclined lower incisors and the proclined uppers. This is typical of all Class 3 cases other than those with a pronounced functional element. Top angle 113°, bottom angle 68°.

becomes the Angle class 2, division 2, and in the Angle class 2 division 1, malocclusion an element of overjet is added to the excessive incisor overlap.

I must say a few words regarding the effect of normal circumdental musculature—to coin a word—upon the positions of the teeth when the skeletal pattern is pre-normal and the lower apical base placed forward to its normal relationship with the upper. You all know that in this type of skeletal pattern, there tends to be a reduction, often considerable, in size of the upper apical base, and a normal or increased size of the lower apical base.

In cases of mild degree, the musculature moves the crowns of the incisors and cheek teeth into normal bucco-lingual relationship, by inclining the lowers lingually and the uppers, buccally and labially. The angle between upper and lower teeth is not, however, normal, being greater than usual, i.e., upper to lower incisors greater than 140 degrees.

With an increasingly abnormal skeletal pattern however, the muscles are unable completely to rectify the coronal relationship of the teeth, with the result that both upper incisors and cheek teeth are in

lingual relationship to the lowers, and a typical Angle Class 3 malocclusion results. On analysing such a case however, it is always found that the muscles have done their best, all the upper teeth being markedly outwardly tilted from their normal axial inclinations, and the lower cheek teeth being linguoclined and the lower incisors retroclined. Any attempts to alter these relationships by orthodontic means, are doomed to relapse, unless retained by purely mechanical means, such as incisor overlap. Even if the incisor relationship can be rendered normal labio-lingually, and retained by overlap, an extremely traumatic occlusion is produced and these teeth are assured of an early loss through parodontal disease.

It is interesting to note that, in the case of Angle class 3 malocclusions, it is possible to differentiate between the true skeletal class 3 and the so-called postural or functional pre-normal occlusion. In the latter case, the upper incisors are either in normal axial inclination, or retroclined, and the lowers, either normal or proclined. I think that this type of pre-normal occlusion never occurs except with an associated pre-normal skeletal malocclusion, often of slight degree.

I have attempted tonight to give the salient points of my views on the ætiology of malocclusion. To cover the subject fully would require a book, rather than a short paper, and I must apologize for any omissions, or lack of clarity, forced upon me by the demands of time, but shall be pleased to try and rectify this to the best of my ability in the discussion.

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BIBLIOGRAPHY

1. Ballard, C. F. Trans. *B.S.S.O.* 1948.
2. Ballard, C. F. and Gwynne-Evans, E. *Dental Record* (1948) 68.1.
3. Brodie, A. G. *A.J.O.* Nov. '41. Aug. '40.
4. Gesell, A. *A.J.O.* July '42.
5. Margolis, H. I. *A.J.O.* 29.571.
6. Rix, R. E. *B.S.S.O.* Trans. 1946.
7. Stockard, C. R. The genetic and endocrine basis for differences in form and behaviour. *Wista Institute of Anatomy & Biology, Philadelphia.*
8. Thompson, J. R. and Brodie, A. G. *J.A.D.A.* 29.925.
9. Tweed, C. H. *A.J.O.* Feb. '45.

Discussion

The President said that anyone who brought forward a relatively new view of orthodontic aetiology must expect a fairly lively discussion. At the beginning of the paper he had found himself wondering whether there was any future for orthodontics at all. If the skeletal pattern was genetically determined and thereby fixed and if the muscle pattern was hereditarily determined and thereby fixed, there did not seem to be very much scope for the orthodontist's intervention and assistance. He had gathered at a later stage of the paper, however, that the musculature pattern could modify itself in a favourable direction, and that had given him some hope. There was no doubt that the subject of muscle action and muscle influence on the tooth relationships was of very great importance and needed a good deal of further exploration.

Mr. K. E. Pringle said that he did not wish to criticise the paper—he agreed with nearly all that Mr. Hovell said, so far as he understood it—but there were certain points that he would like clarified.

Mr. Hovell had spoken of the analysis of cases by cephalometric means, and he would like to know how Mr. Hovell did that and how he ascertained the degree of mesial tilt of cheek teeth that had advanced after the incisors came forward. He believed Mr. Hovell had said in a recent communication that in Class II, Division 2, all the upper teeth came forward but not by tilting, and that therefore, rather than 7's in the upper being taken out, 4's could be removed. He did not know whether he had understood that aright. In Class II, Division 2, the apices of the upper central incisors were forward and the crowns were back, whereas all the others had somehow slipped, but removal of upper first premolars, although it might be the only answer that could be given, did not produce a very satisfactory result; all the teeth, both upper and lower, sloped back and a condition was obtained which was something like the true close bite that Mr. Hovell described.

Mr. Hovell had said that orthodontists had entirely abandoned the idea of advancing the mandible, but he might agree that there were occasional exceptions. Would he explain what happened in a Class II, Division 1, case when, with no other treatment and no bow on the front of the upper incisors, one simply expanded the upper arch and the occlusion changed? That happened sometimes, though not by any means always. He did not think it happened at all if the case was a skeletal Class II, as Mr. Hovell described it, but it seemed that there were cases where the lower dental arch came into a more forward position, although, as far as he could see, one had not done anything but take the upper arch back.

He was interested in what Mr. Hovell had said about the deep incisor overlap where both upper and lower incisors were sloping back. In 1936 he had examined models showing the results of early extractions, and he had been puzzled at that time, because 70 per cent of the cases in which lower teeth only had been lost showed a deep incisor overlap and a low percentage of the cases in which upper teeth only had been lost showed a deep incisor overlap, whereas it was present in 80 per cent of the cases in which both upper and lower teeth had been lost.

Miss L. M. Clinch said she would like to ask Mr. Hovell what he meant by " persistent infantile lip posture " because her experience was that infants had the same lip posture as adults. She did not think that normally the lip posture altered. As Mr. Rix had shown clearly, persistent infantile swallow was a different matter.

She thought that there were cases

where the mandible was in a postnormal position and where this postnormality could be corrected. She used intermaxillary traction to a considerable extent, with what she thought were successful results. She did not think it would be possible to draw definite conclusions until a good deal more cephalometric analysis was done in this country. She doubted very much whether orthodontists in America who were doing the work drew the conclusions which Mr. Hovell had drawn. She was also under the impression that Mr. Broadbent, the pioneer in the work, would not agree with all that Mr. Hovell had said and would not wish so thoroughly to revolutionise the basis of treatment.

She was very interested in what Mr. Hovell had said and she thought it was good for orthodontists to be made to think about the new theories that he put forward. She was quite sure that there was a great deal in what he had said, but she wished that he had not said quite so much without having any basis of proof.

Mr. C. F. BALLARD said that he was inclined to agree with what Miss Clinch had said about infantile lip posture. He thought it was Mr. Gwynne-Evans who had first used the term and that it might be a little misleading. At the Eastman Dental Hospital a scheme had recently been started for filming infants; they were to be re-filmed every three months during the first year and then every six months for several years, and the way in which the lip posture developed would be watched. He thought that the infant which kept its lips apart would maintain that lip posture and that when it became a more mature child it would still have its lips apart. Amongst those that had been filmed there were many infants who had a perfectly normal lip posture and there were some who had a lip posture which looked as though it would produce a Class I, Division 1, incisor relationship, whilst others looked as though they would develop a Class II incisor relationship. He thought that the expression " infantile lip posture " should not be used until further evidence on the maturation of the facial musculature had been collected.

Mr. MACLACHLAN said that Mr. Hovell's statement that it was not possible to alter the skeletal pattern prompted him to refer to a very unusual case of unilateral hypertrophy of the condyle recently reported in the *British Dental Journal*. There was an excellent series of photographs, which was very interesting. They showed the progressive growth (the case was progressive), and the final result was an occlusal trend which was markedly oblique. Surely that showed that there was an alteration in the mandible through the pathological process. The maxilla showed a marked decrease of the vertical dimension on one side in relation to the other. That appeared to show that the external force of the abnormal mandible had in some way altered what appeared to him to be the skeletal pattern of the maxilla. In the case in question it was a pathological process, but was not it possible that external forces such as orthodontic treatment could produce a similar result?

Mr. J. W. SOFTLEY said that he was interested in the question of whether it was possible to alter the relationship between the apical bases of the jaws. He thought that the truth probably lay halfwaybetween the two extremes, namely, the view put forward by Mr. Hovell, that the relationship could not be altered at all, and the view that one could advance the mandible more or less at will. He thought there were some cases which responded extremely quickly to intermaxillary traction and to the use of Andresen plates, and in those cases he could not see how the effect could have been produced otherwise than by moving the mandible forwards. There was also the question of the maxilla, and surely all orthodontists had seen cases of children who sucked their thumbs and

produced what Mr. Hovell would call skeletal Class II by actually protruding the premaxilla. If they could pull the premaxilla forward by pressure from behind, he did not see why orthodontists could not push it back by putting pressure from the outside.

He thought it was important in these conditions to bear in mind that the patient was growing all the time. If a patient had brought the premaxilla forwards by thumb sucking, pressure on the outside would not push the premaxilla horizontally backwards but would alter the angle of the normal forward and downward growth of the maxilla by decreasing the forward component. The final result being to bring the maxilla back to its normal relation with the mandible.

Mr. B. C. LEIGHTON asked whether Mr. Hovell thought that cases of deep overbite were due to over-eruption of the lower incisors. If so, could he explain why the over-bite was reduced in Class II, Division 1, cases when the molar relationship was corrected?

Mr. W. LITTLEFIELD expressed his appreciation of Mr. Hovell's able exposition and sajd there was one question that he would like to ask. Mr. Hovell had said that the skeletal pattern was unalterable and he had also said that the teeth were in balance within the musculature. What were his views on cases which were treated by the Kostecka operation, when the skeletal pattern was obviously altered and the muscle pattern was not altered? Did he consider that those cases relapsed?

Mr. L. RUSSELL MARSH asked how Mr. Hovell measured the skeletal relationship. It seemed to him that the skeletal relationship was changing all the time. Did Mr. Hovell measure what was going to happen in the future or what was there at the moment, and, if he measured what was there at the moment, how could he forsee what development would take place with the possible change in the skeletal relationship?

MISS R. CASELEY said that she would like to hear Mr. Hovell's observations on some cases, which were encountered in orthodontic practice, of children who were obviously genetically Class III. When the orthodontist saw the child, perhaps at the age of 5 years, the child had a cross bite which was very obvious in the deciduous dentition. By putting in any upper Badcock plate the orthodontist overcame the cross bite, and, although the Class III genetic pattern remained, and it was very obvious as the child grew older, the cross bite did not appear again and there was no obvious deflection of the mandibular arch or of the mandible.

Mr. C. P. ADAMS said that Mr. Hovell had covered a very wide field in discussing the aetiology of malocclusion involving heredity, growth, development, and last, but by no means least, the influence of the muscles and their function on the development of the abnormalities, and he thought that, whether intentionally or not, Mr. Hovell had allocated to function and posture the dominating influence in the generation of the abnormalities. It seemed to him very difficult to understand how the muscles could take over such a complete and deciding influence on the generation of malocclusion. In view of the great work that had been done by Professor Brash, and the support which had been given to that work by practitioners of experience, in attributing to heredity a very important influence, he wondered whether Mr. Hovell would consider that and perhaps agree that the teeth and the dental arches themselves, quite apart from the development of the bone, had a heredity factor of their own, because the paper gave the impression that Mr. Hovell had generalised all malocclusions as resulting from the influence of the muscles and their posture, and, as the paper proceeded, particular instances arose which seemed to be inexplicable on that basis.

It was difficult, in the case of a paper of such scope and read so quickly, to

collect one's thoughts sufficiently to pick out certain cases that might contradict what was said in the paper, but there were two which occured to him and which he met from time to time.

The first of these cases related to the matter of buccal segments. It was well known that, when the first molars were released and moved under their own influence, they not only moved forward but rotated, and why should it be that the buccal segments moved forward without rotation not only of the first molars, but of the other teeth as well? There were many cases in which it appeared that the buccal segments might have movedforward and in which this rotation had not taken place.

Another point which interested him was the treatment and the prospects of the Class III cases. According to what Mr. Hovell had said, it would appear that the patient was condemned either to keeping the Class III relationship or to having it treated and losing the teeth very shortly through parodontal disease. He thought the prospect was rather grim but that a good many of these cases could be treated by bringing the teeth into their correct relationship, even though the occlusion was traumatogenic. The patient would have the upper teeth and they would do him better service in that position than in the position behind the lower incisors.

He would like to have Mr. Hovell's views on that point and also on the question of the forward movement which was alleged to take place and in which no rotation of the first molars appeared.

Mr. E. K. Breakspear said that until now he had always thought of the genetic factors as affecting either the relationship of the two jaws, so that there was inherited Angle Class II, Division2, or the relationship betwen the size of the teeth and the size of the jaws. If each jaw could be inherited separately it would make the subject still more complicated. He would like to know more about that and would be glad if Mr. Hovell could give him references to further information on the subject. He would also like to know whether Mr. Hovell had come across anything in his experience which suggested that this applied to human beings as well as to dogs.

Mr. W. J. Tulley said it seemed to him that Mr. Hovell's dogmatic statement that the apical base relationship could not be changed was contrary to the true principles of bone biology and orthopædics. He thought it was very largely true but he did not think it should be stated quite so dogmatically, because the anatomy of the joint allowed a considerable change in the articulation. The disc was thought nowadays not to be a hyaline cartilage but to be a fibro-cartilage with the fibrous tissue predominating, and he thought that some change in its shape could be achieved by orthodontic therapy.

He would like to ask Mr. Hovell whether any work had been done on the incisor inclination in relation to the condylar path, because anatomists in this country believed that the inclination of the buccal aspect of the upper incisors bore a constant relationship to the condylar movement.

He would like to see more work done on the temporo-mandibular joint and the changes in that joint during orthodontic therapy, and that could be done by cephalometric analysis.

Mr. Grossman said that he was doubtful about the statement that the mandible could not move in its relation to the maxilla. Clinical experience by others and by him has convinced him that the maxillo-mandibular relationship can change due to adaptive changes of the condyle and the articulator fossa. As an example, he quoted cases where malocclusions were treated with an activator which was not filed out and therefore did not allow individual tooth movement. This meant that the maxillo-mandibular relationship could only have been changed either by moving the whole dental arch,

or by changes in the T.M. Joint.

From the cases treated it was quite obvious that the former could not alone be responsible for the obvious changes. He would gladly put these cases at the disposal of Mr. Hovell.

Histological examination of the T.M. Joint of animals treated with the help of an activator confirmed clinical findings. It has also recently been established that the condyle adopts a characteristic shape in mal-occlusions. Some investigators even go so far as to say that they are able to diagnose certain typical malocclusions (Angle Class II/2 in particular) from the form and shape of the condylar head.

He had recently treated a large number of Class III cases, where again no allowance was brought to bear on the condyle and the temporo-mandibular joint. He could not see why the condyle should be the only part which did not adapt itself to a new function and a new occlusion. The paradontal tissues changed and adapted themselves to a new occlusion and a new function. That was seen under the influence of the monobloc when Class II, Division 1 cases were being treated. If the alveolar bone was influenced, why should not the condylar bone be influenced? Why should the temporo-mandibular joint be the only joint in the human being which did not respond to changing influences and which did not adapt itself to those influences ?

He thought that before any firm statement was made on the subject more investigation was necessary.

Mr. J. H. HOVELL, in replying to the discussion, said that cephalometric analysis was quite easy to carry out.

(*Drawing on blackboard*)

One took a lateral radiograph and traced the Frankfort and mandibular planes and the incisors and reduced these to normal relationships to the planes; in other words, one drew through the Frankfort plane a line at about 110° and through the mandibular plane a line at about 90° passing through the apices of the respective incisor teeth. If when that was done the incisor relationship was normal the apical base relationship was normal, if the lower incisors were behind the upper incisors the apical base relationship was postnormal, and if the lower incisors were in front of the upper incisors the apical base relationship was prenormal.

Mr. K. E. PRINGLE asked whether Mr. Hovell was referring to the incisor apical base or the whole apical base.

Mr. J. H. HOVELL said he was referring to the whole apical base. The apical base was a continuous thing. The whole mandibular base was either too far forward or too far back.

In regard to Class II, Division 2, there was a passage in his paper which he had omitted to read and in which he said that the combination of a postnormal skeletal pattern with faulty lip posture would increase the malocclusion produced by the latter. For example, the Mershon true close bite became an Angle Class II, Division 2, with a postnormal apical base relationship, and the only way to correct the postnormal incisor and canine was to extract the upper first premolars. The result was unsatisfactory but it was the best that could be achieved, because it was not possible to alter the muscle pattern.

The skeletal pattern was established very early in life, at the age of about 6 months, and from that time onwards the development was in a straight line and the skeletal pattern relationship between the upper and lower jaws would not change. If it was 1 unit postnormal at the age of 1 year, it would be the same at the age of 10 years and at the age of 20 years.

A MEMBER asked whether it was a presumption to consider that the apices of the incisor teeth were in correct relationship.

Mr. J. H. HOVELL said that they were in correct relationship with the skeletal base, because the incisors and cheek teeth were all in contact all the way round. He did not

think that was a presumption at all. He thought it was when he first read what Margolis and others said about it, but, on giving the matter more serious thought, he decided that it was perfectly logical.

In regard to the expansion of the upper arch and the change of occlusion in Class II, Division 1, cases, that occured occasionally but not very often. He thought the reason for it was that the expansion had taken place at the time when the lip posture was maturing, and, as a result, added pressure had been brought to bear on the incisor teeth and at the same time more space was given to them. The lower lip came outside them and the lip posture became more normal. Therefore the lower arch came forward normally. The occlusal interferences with normal growth of the upper arch were abolished by the expansion, and the normal lip pressure pushed the upper arch back and the lower arch forward. That occured in only a few cases.

Mr. Ballard had come to his rescue in replying to Miss Clinch. Mr. Ballard knew much more about lip posture and lip function then he did and had answered Miss Clinch's question much better than he could, by saying that infantile lip posture—it might be better to say a faulty lip posture—was liable to mature.

In regard to the work done by Dr. Broadbent in America, to which Miss Clinch had referred, the Americans had done a great deal of work on growth but had not realised the physiological importance of muscle action upon the position of the teeth. That was why they had not obtained the great benefit which they could have obtained from their own research work. It had been left to Mr. Ballard to realise the value of the research work which had been done by Americans on the growth of the jaws and the development of the jaws.

In reply to Mr. Maclachlan, he would say that he had excluded gross pathology from his paper as being outside the scope of orthodontic treatment. Nobody would try to treat the teeth by methods of which were damaging, and he did not think that the result of such methods could justly be compared with what happened when the very gentle force of intermaxillary traction by a monobloc was used. He would like to ask whether Mr. Grossman had made a cephalometric analysis of cases in which he had used a monobloc and, as he said, the actual jaw relationship had changed, because a number of teeth could move all together; the teeth need not be moved one by one.

In regard to Mr. Softley's remarks, he did not think that the quick response to intermaxillary traction had anything to do with apical base relationship. He thought it had to do with the musculature of the patient and the question of the comparison in size of bone with size of teeth. If one tried to move back upper buccal segments in cases where the upper jaw was very underdeveloped and one had not taken out the upper second molars, they went back very slowly, but if they were only slightly underdeveloped they went back more quickly.

Research had shown that skeletal patterns tended to improve during development; in other words, there was a change for the better in some skeletal patterns, and that might explain some of the cases in which there was an improvement in the mandibular plane angle during the course of treatment; it would have improved without treatment.

There were three factors in malocclusion, namely, muscle function, apical base relationship and size of apical base in relation to teeth. Some malocclusions were due entirely to one factor and some were due entirely to another. He would not belittle Professor Brash's work. He had pointed out that one had to diagnose which factor was responsible for any particular malocclusion. Professor Brash had rightly stressed the importance of heredity. If the jaws were by nature ill-

fitting, the teeth would be ill-fitting, but faulty lip posture and muscle function, and so on, as well as skeletal pattern, were probably inherited.

On the question of heredity in dogs, to which Mr. Breakspear had referred, the work had been done by the late Dr. Stockard, who had written a book on the inheritance of skeletal patterns in dogs and endeavoured to correlate this with endocrine function.

In regard to thumb sucking, to which Mr. Sofdley had referred, all orthodontists would have noticed that some thumb-suckers produced gross deformities and some produced very slight deformities. If the cases were analysed, it would be found that the ones which produced gross deformities were the ones that had already a grossly abnormal skeletal pattern. There was an hereditary deformity of the basal bone and therefore a vastly increased deformity produced by thumb-sucking. The thumb-sucking pushed forward the upper incisor teeth and with them the alveolar bone, and at the same time the tongue was not normally held in the roof of the mouth in those cases, and there was a narrowing of the palatal area and the alveolar bone became narrowed. If that was imposed upon a Class II skeletal pattern, the deformity was very much increased. He did not think that thumb-sucking in any way affected the basal bone of the maxilla; it was only the alveolar bone which was affected.

The condylar path, to which Mr. Tulley had referred, was a matter of very considerable importance from the point of view of parodontal disease, and much work needed to be done upon it, especially in connection with incisor relationships. It varied according to the Frankfort mandibular angle. It offered a field for research work both orthodontically and parodontically.

On the question of why the condyle should not change shape when the alveolar bone did so, when the teeth were lost the alveolar bone was lost but the condyle was not lost. The position of the teeth was determined by the muscles. The shape, size and position of the alveolar bone were determined entirely by the position of the teeth. The alveolar bone did not determine the position of the teeth, and when the teeth were lost it went also. The condyle was part of the basal skeleton, and one would not expect it to atrophy and disappear when the teeth were removed, in the way that the alveolar bone did, nor would one expect it to be so easily changeable as the alveolar bone was. When the teeth were moved by orthodontic means, the alveolar bone changed, but one would not expect the condyle to do so.

Miss Caseley had referred to cross bite in the deciduous dentition and had said that it did not recur after it had been treated by a Badcock plate.

When there was a faulty skeletal pattern the muscles tried to correct it.

(*Drawing on blackboard and explanation*)

The crowns of the permanent teeth were larger relatively to the roots than those of the deciduous teeth, and that was why it was found that muscle action in permanent teeth produced a greater effect in the relation of the crowns of the teeth to the apical base than it produced in the deciduous dentition. Therefore all deformities due to faulty muscle action were greater in the permanent dentition, and, in cases in which muscle action was trying to overcome skeletal deformity, the deformity was overcome more readily in the permanent dentition that it was in the deciduous dentition. There were therefore two explanations which could be offered for Miss Caseley's case. One was the larger size of the permanent teeth, which enabled the muscles to succeed in bringing them into correct relationship, and the other was the possibility of the deformity being caused by a slightly faulty swallow, which had improved.

In regard to the Kostecka operation, when that operation was performed there

were very proclined upper incisors and very retroclined lower incisors owing to the efforts of the muscles to move the crowns of the teeth into normal relationship and to overcome the prenormal apical base relationship.
(Drawing on blackboard)

When one sectioned the mandible through the ascending ramus and moved the body distally, one had to bring the lower incisor back further than would appear to be necessary. The tongue was also taken back, as were some of the attachments of the lips while some of these remained behind. Therefore the pressure from the lips on the lower incisors was decreased, and after the mandible had been taken back the incisor teeth tended to relapse to a certain extent into a more vertical position. That was one of the reasons why after a Kostecka operation a case might in course of time relapse. It was not a relapse of the bone itself, but it was due to the fact that the lower incisors uprighted themselves owing to the lessening of the lip pressure which had previously held them back.

In a Kostecka operation it was necessary to immobilise the mandible for at least twelve weeks in order to be quite sure that there would be no relapse, otherwise, if the time of immobilisation was shorter, the patient might develop an anterior open bite, and tend to relapse into its former position.

A Case of an Unerupted First Permanent Molar, with Second Premolar and Second and Third Molars in Position

D. F. Glass, L.D.S., R.C.S.(Eng.)

An Examination of the literature on the physiology of normal eruption has led me to believe that practically nothing is known of the normal forces which extrude the tooth from the bone of the jaw. Uneruptions and ectopic eruptions are relatively common, and a study of these abnormalities may help us to understand normal eruption.

History

Miss Williams, age twenty-six years, came to me complaining of tooth ache. She had been seen a month before by her own dentist who examined her and could find no cause for pain.

Examination

On examination no cavities could be found, and the mouth looked in good condition. Missing teeth were $\frac{8\ 3}{6}|\frac{6\ 8}{8}$ $\underline{3}|$ is a bridge.

FIGURE 1. *Reconstructed Models*

The pain was greater on the right side, although it was not confined to that side only. She thought it was confined to the lower jaw, but there was considerable referred pain.

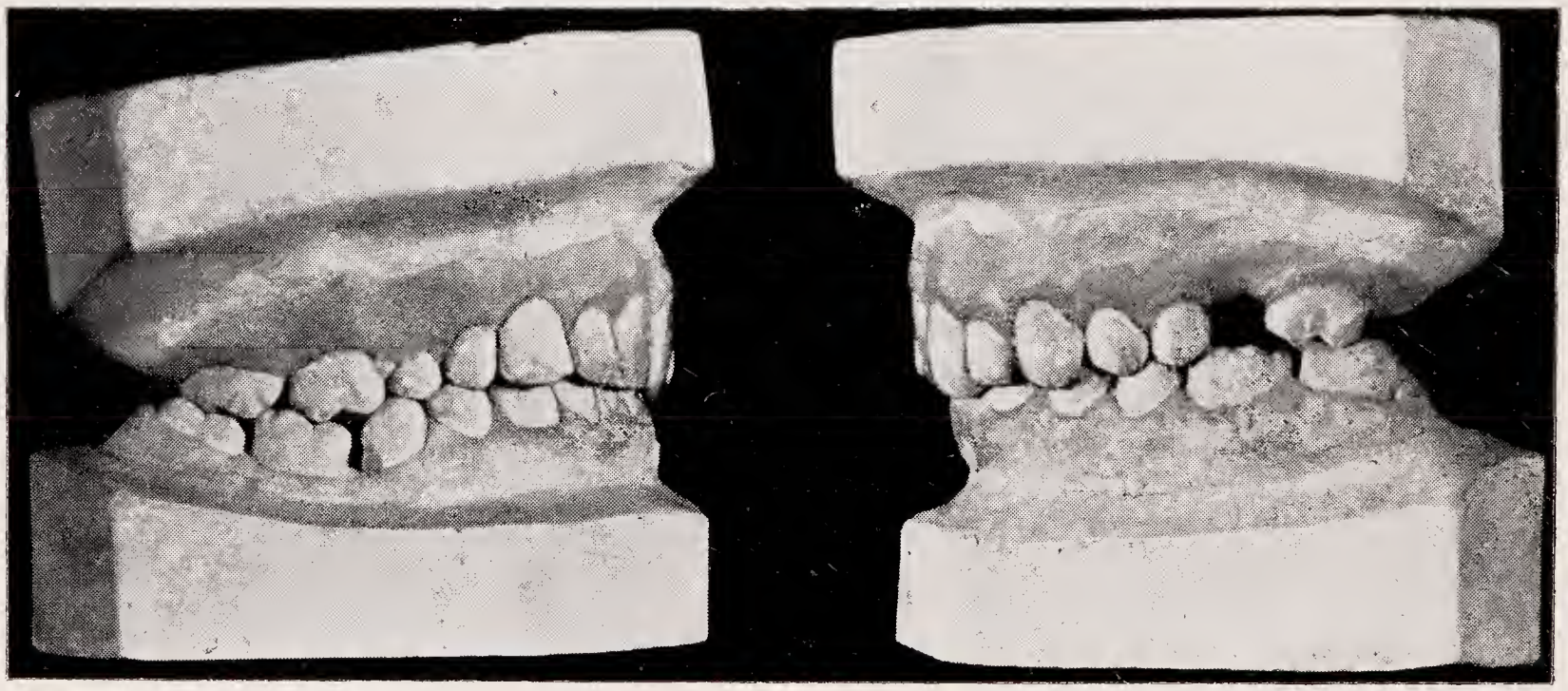


FIGURE 1.

Short Communication presented to the meeting on 13th March.

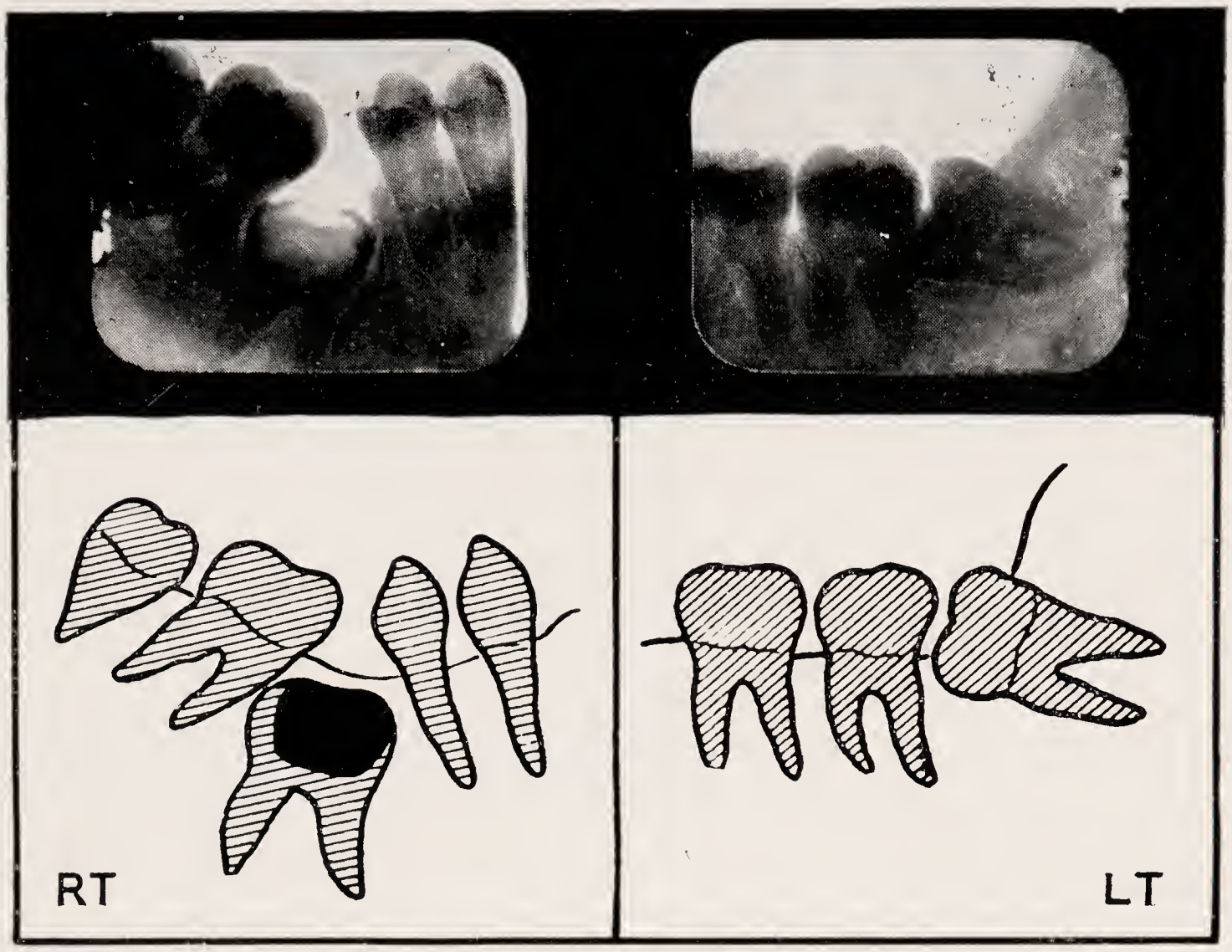


FIG. 2.

FIGURE 2. *X-rays*

As you can see there is ample cause for complaint in these two pictures.

The LEFT side, although of interest from a surgical point of view, is not unusual.

The RIGHT, however, is of an interest from a surgical and also from an etiological point of view.

The $\overline{4}|$ and $\overline{5}|$ have either tilted distally owing to no distal contact point, while the apex has remained fixed, OR the crowns have remained where they erupted and the apices have been carried forward by the normal forward development.

The $\overline{7}|$ has erupted as though no $\overline{6}|$ existed, except perhaps that the roots have been prevented from mesial shift by the $\overline{6}|$.

The $\overline{6}|$ is completely blocked by its two neighbours and the entire crown is carious. The condition of the crown of this tooth is similar to that of an unerupted deciduous molar, as shown last month by Mr. Tulley. Figure 3. He thinks that in such cases the crown dentine is absorbed by osteoclastic action, leaving an enamel shell. I am inclined to believe these teeth must have some connection with the exterior, and the condition is due to caries, not osteoclasts. However, I did not see a sinus, but that does not mean one did not exist.

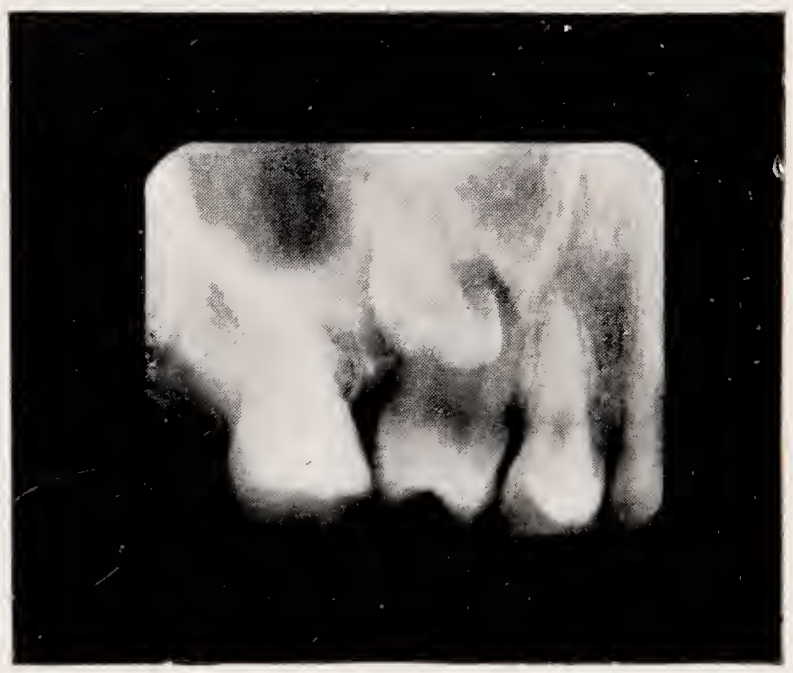


FIGURE 3.

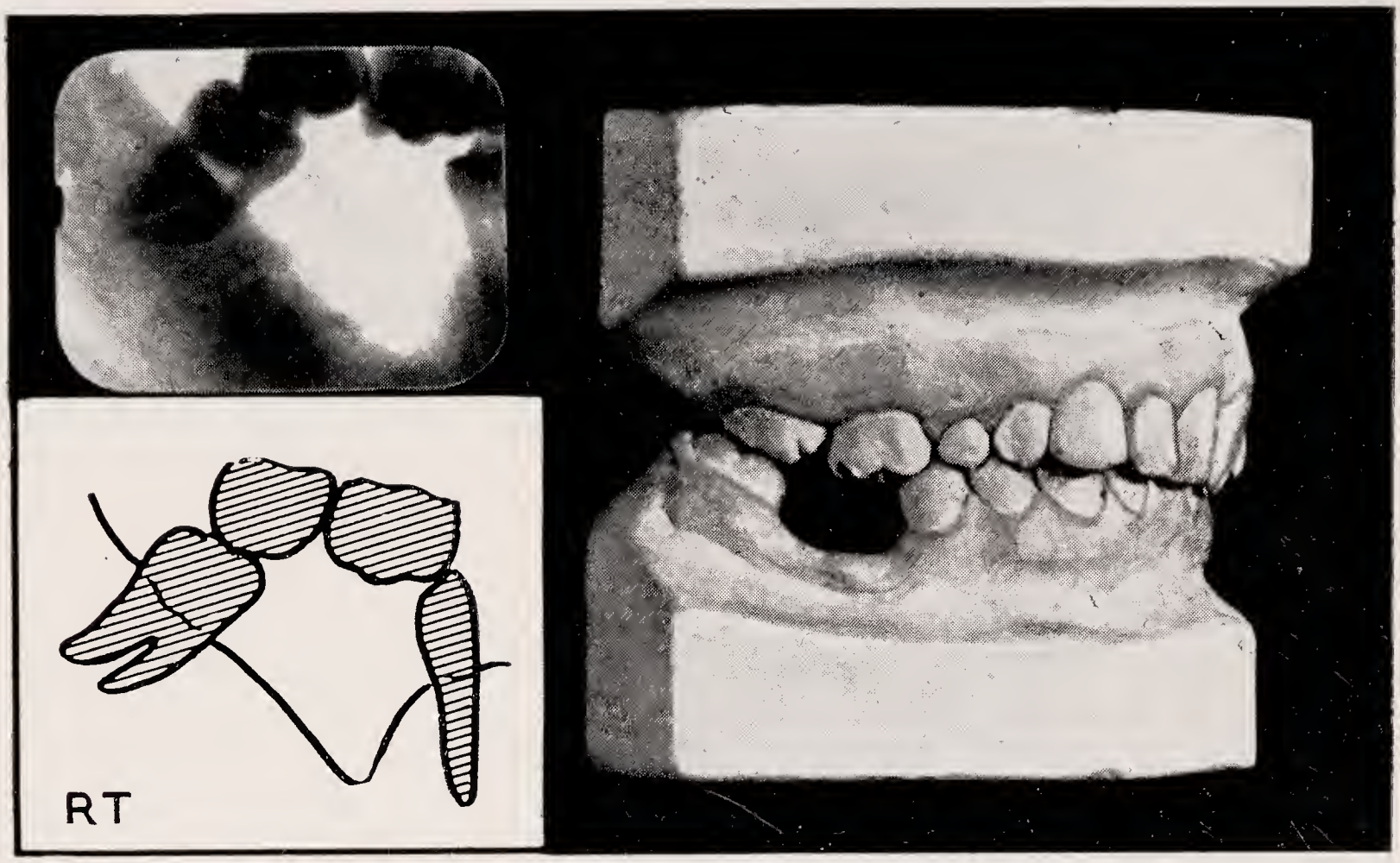


FIGURE 4.

SURGERY

The right side was tackled first and although I at one time considered removal of the $\overline{6}|$ alone, I soon changed my mind when I had removed the outer plate of bone. I removed the $\overline{7}|$ and eventually the $\overline{6}|$ which presented some difficulty as the crown was only a shell of brittle enamel.

Two months later the left $|\overline{8}$ was removed. Both operations were performed under 3% Novutox regional block with no premedication, and no post operational complications. Needless to say she was a good patient.

FIGURE 4. *X-ray of jaw after extraction*

ETIOLOGY

I cannot look at a condition such as this without wondering how it was produced, and an analysis of my thoughts is as follows:

There are two main reasons why teeth remain in the jaws covered by alveolar bone:

(1) Mechanical impactions.

(2) Non-mechanical impactions.

(1) *Mechanical.* The lower left $|\overline{8}$ represents a typical mechanical impaction. Lack of room has prevented this tooth from taking its proper place in the jaw.

(2) *Non-Mechanical.* This condition is one where the tooth remains in the bone of the jaw, reaches full development, and from X-ray and other examinations is not impeded from erupting by lack of development or irregular positioning of its neighbouring teeth.

Now the right side of this jaw has a $\overline{6}|$ which has failed to erupt. Let us attempt to trace the cause of this uneruption.

FIGURE 5. *Developmental sketches*

Here you see the sketches of the development of the jaw at various ages; $3\frac{1}{2}$, 6, and 20 years.

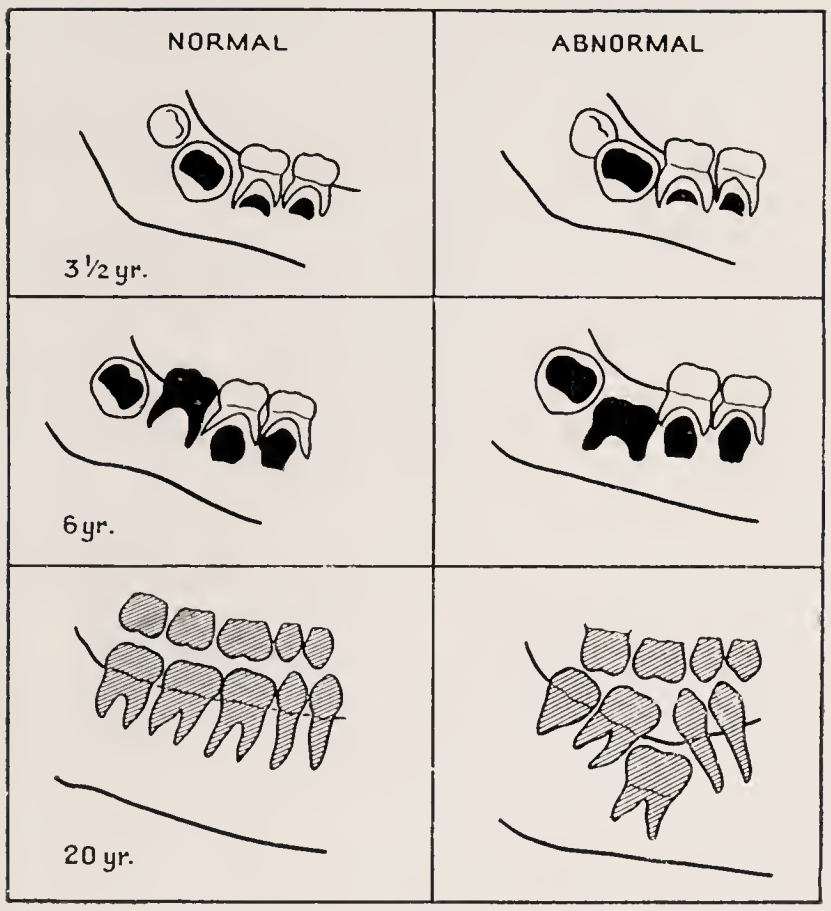


FIGURE 5.

At $3\frac{1}{2}$ *years* I think that normal and abnormal were the same. The $\overline{7}|$ which is just starting to calcify lies superiorly and somewhat distally to the $\overline{6}|$, the crown of which is completely formed. The $\overline{5}|$ is forming below, and anteriorly to the $\overline{6}|$, and $\overline{E}|$ is in occlusion and is fully formed.

At 6 *years*, normal and abnormal present two different pictures:

Normal.

$\overline{7}|$ Crown formed, facing forwards.

$\overline{6}|$ Erupted and in occlusion, roots nearly complete.

$\overline{5}|$ Crown formed, but 4 years before eruption.

$\overline{E}|$ In occlusion, decalcification not yet started.

Abnormal.

This is similar to the normal, except for the $\overline{6}|$ which although calcified to the same degree, remains unerupted, submerged between $|\overline{7}$ and $|\overline{5}$.

At 20 *years*. Here we see the jaws in occlusion.

There is no $\underline{8}|$ present.

$\overline{8}|$ and $\overline{7}|$ have now erupted into this mesiocclusion to fill $\overline{6}|$ space, with the resulting tilt mesially of the crowns. Remembering the circular eruptional path of these teeth, I would say the apices are normally placed in the jaw.

$\overline{6}|$ is now fully developed and in the same position as for three and a half years.

$\overline{5}|$ has erupted normally; the apex is normally placed, but the occlusion is distal to the $\underline{5}|$.

Had the $\overline{6}|$ erupted normally, I think we should have had an impacted $\overline{8}|$ with normal occlusion of the $\overline{7}|$ and $\overline{5}|$. However, this occlusal variation here seen is a most efficient modification.

Of the many possible causes for this conditions the most likely are

(1) Trauma to the developing $\overline{6}|$ at an early age.

(2) Abscess of distal root of $\overline{E}|$, this root being retained during, and long after the period of active eruption of $\overline{6}|$

(3) Following this, $|\overline{6}$ now impacted between $\overline{7}|$ and $\overline{5}|$ which are erupting to fill the $\overline{6}|$ space.

The only weakness in this reasoning is why we do not get more suppressed and unerupted $\overline{6}|$?

Of course we shall never know the real cause of this uneruption, but I hope the case will be of some interest in the vast and little understood subject of eruption and non-eruption.

Professor Manley's Pathological Report on $\underline{E}$ *Fig.* 3, *Extracted since the Discussion.*

" It is a most interesting specimen. There is no doubt about it that the gross destruction of the tooth was due to a purely resorptive process, where osteoblasts and osteoclasts each play their part. The tooth structure has been destroyed and replaced by osteoid tissue. There is quite an exten-

sive area of this bony material, and in the middle of it one is able to see islands of dentine cut transversely and which have evaded resorption. As you know, this osteoblastic and osteoclastic condition has been described by Fish as an odontoclastoma, and there is indeed some justification for using this term. In addition and quite surprisingly, there is evidence of caries of the enamel *on the surface of the tooth*. In sections stained by Gram the dentine has become slightly involved, but this lesion is quite distinct from the grosser one involving tooth destruction. It seems inevitable that this unerupted tooth had communication with the surface, or alternatively infection via the periodontal membrane of an adjacent tooth. It is quite a characteristic lesion of idiopathic resorption, and there is no evidence of any caries other than the one confined to a small area on the surface of the tooth."

DISCUSSION

Professor M. A. RUSHTON said that Mr. Glass had not stated his reason for thinking that the destruction of the crown of the unerupted first molar was due to caries. In such cases it was usually due to resorption by osteoclasts. If it were due to caries, which was not quite impossible, with such an amount of carious destruction there would certainly have been evidence of infection at the apex of the tooth. Unfortunately the X-ray photograph did not show the apex, but he felt sure that Mr. Glass had seen the apex, as he had put it in the diagram, and he would like to ask what the condition of the apex was.

Mr. C. F. BALLARD said that he had seen a number of cases of unerupted first permanent molars, both in the lower jaw and in the upper jaw. He had always assumed that the cause was the same in the permanent unerupted teeth as it was in the deciduous unerupted teeth, in other words, that the processes round the root resulted in ankylosis, which in the deciduous teeth reversed itself later on. He would be interested to know whether, on surgical removal, Mr. Glass had found ankylosis of the roots, although at 20 perhaps the process had reversed itself.

Mr. W. J. TULLEY said that at the last meeting he had described a case of an unerupted second deciduous molar lying in loose granulation tissue just under the antral floor and with no connection with the mouth. In that case there must have been osteoclastic activity and not any carious process, because there was no connection with the exterior.

Mr. H. G. WATKINS said that the old-fashioned nomenclature such as " six-year-old molar " should be abandoned, and he wished that the Council would lay stress on that in its publications. The term " premolar " should be used instead of " bicuspid." There was no need to use the term " third *permanent* molar," because there was no third deciduous molar, and as there were no deciduous premolars there was no need to use the word " permanent " in the term " first permanent premolar " or " second permanent premolar." He suggested that the Editor should correct any wrong terms which were used in papers and other communications.

Professor H. F. HUMPHREYS said that it was quite common to find six-year-old molars not fully erupted, and the interest of Mr. Glass's case lay in the question whether the destruction of the crown was due to caries or to absorption by osteoclasts. It might be possible to decide that question if enough of the tooth had been saved to be sent to a pathological laboratory for section.

It might seem impossible for caries to occur in an unerupted tooth, but that was not so. Several cases had been reported during the last thirty or forty years. The tooth erupted just enough to expose the crown, and a little caries started in the fissure, and then the gum closed over the

tooth again, but that did not prevent the caries continuing.

Mr. A. J. Walpole Day said he was very interested in the case described by Mr. Glass, because one of the first patients that he had had when he was in general practice was a similar case. The patient had a lower 6 which was not unerupted but the occlusal surface was partially erupted and the interior fissure was probed and found to be carious. The X-ray showed that not only were the apices in close proximity to the lower border but they actually projected beyond it and could be palpated. He therefore took the line of least resistance and filled the carious fissure, and, as far as he knew, the patient still had the tooth.

Another case which might throw some light on the subject was that of a patient now aged about 9 years. When the patient was 7 years old, a colleague of his had shown him a radiograph of the case and asked him his opinion; there were no lower 5's present. Last year his colleague repeated the radiographs of the case, and there was a suspicion of a lower 5 developing on both sides. There were now definitely two cusps there and the 5 looked as though it might eventually become a perfectly normal tooth.

Something of a similar nature might have occured in the case of the first permanent molar in question. Its development might have been delayed sufficiently long for the second permanent molar to travel forward over it and prevent its eruption, and subsequently the first permanent molar might have completely formed but been unable to erupt owing to the purely mechanical impaction.

Mr. D. F. Glass, in replying to the discussion, said that he had not kept the tooth in question, as he had not realised its value, and he was afraid he knew very little about it.

He thought Professor Humphreys was right, and that at one time the tooth had had a connection with the exterior, that connection being due either to the eruption of the tooth or to a sinus from the distal root of the E, and that the cavity in the 6 was due to caries.

The tooth to which Mr. Tulley referred was decalcified and was further away from the surface than the tooth in the present case, and it was possible that it had been decalcified by osteoclasts.

He was sorry that the X-ray photograph did not show the apex of the tooth, but the patient had complained that the film was a little too painful, so he had not taken a lateral.

He did not think that the roots were ankylosed, because, once the crown had crumbled away and he was able to get an elevator between the roots and separate them, he was able to elevate them in the normal way. If it had been ankylosed, he thought he might not have been able to get it out.

He was sorry if he had referred to the tooth as a " six-year-old molar," because that was a term that he did not normally use. He thought it was a waste of space, energy and time to refer to a " first permanent molar," " second permanent molar " or " third permanent molar "; it was much better to call it a " 6," " 7 " or " 8."

He wished to thank Miss Smyth for her kindness in helping him with the short communication which he had presented.

Factors in the Aetiology of Post Normal Occlusion

PROFESSOR H. F. HUMPHREYS, D.L., M.B., Ch.B., M.D.S., F.D.S.

In opening this discussion on post-normal occlusion we shall assume—perhaps with undue optimism—that you have read the account of our investigation which was published in the British Dental Journal in January of this year (1950). Its methods were statistical and no discussion of results embodied in statistical tables can be profitable if these tables are seen for the first time flashed on to a screen by the opening speaker. They must be studied at leisure and it was therefore after discussion with your late President that the decision was made to publish an account of the enquiry in advance of this meeting of your Society. This account when first written up contained more than 30 tables: we thought this too much for the ordinary readers' endurance, so we reduced most of those which embodied negative results—i.e., those in which no significant correlations emerged—to a simple statement in the text of the percentages obtained. This makes the report easier to read, but it is perhaps desirable that we should begin by a restatement of some of the more important facts it contained.

The enquiry was made possible by a combination of circumstances; the number, efficiency and highly developed character of the child welfare clinics in the city of Birmingham; the recent creation of an Institute of Child Health to ensure close liaision between these clinics, the Children's Hospital and the University; the existence of a University Department of Medical Statistics. And it is believed to be the first investigation of its kind to be carried out on a large scale on pre-school children. The methods of observation are described in the full report and we have confidence in their soundness because we were advised and assisted at every turn by experts, statistical and clinical; while errors due to the personal equation of the observer were reduced to a minimum by the fact that every one of the children—together with the parents and siblings—were examined by the same dental surgeon (Mr. Leighton).

A pilot investigation led us to an expectation of finding postnormal occlusion in about 25 per cent of the children and this expectation was fulfilled, the number being 681 out of 2,711. Statistical balance was obtained by reducing these to 500 in the manner described and selecting at random 500 other children with normal occlusion as controls. It was these 1,000 children, their parents and their siblings who were subjected to the full examination and questioning described in the report and embodied in the chart we shew. We used the same criteria of postnormality as those employed by Mr. Ainsworth in his report to the Medical Research Council in 1925 and our figures for its incidence in pre-school children (27 per cent in boys and 23 per cent in girls) were just a little higher than those obtained by him from children, mainly of school age (25 per cent for boys and 21 per cent for girls). They are also in accord with the figures of other observers in Sweden and America. It appears therefore that we are confronted with an abnormality affecting about one quarter of the populations of European stock, of people living under as wide a range of environmental conditions as

Paper presented to the meeting on 13th March.

modern civilisation allows.

Our investigation of these environmental conditions yielded no evidence that they had any important bearing on our problem. But this evidence, negative though it be, is not without importance since text books invoke their aid in explanation of the abnormality with a constancy which shows no sign of flagging. The pre-natal health of the Mother, the character of the labour, the health of either mother or child during the suckling period, nutritional variations in the child's diet, particularly as regards vitamin intake, all appeared to be without any definite effect. The widespread belief that post-normality is due to the modern substitution of bottle for breast feeding finds no support from our figures. The hypothesis, so generally stated in text books that it may be almost regarded as orthodox dogma, that the condition is due to mouth breathing induced by enlarged tonsils, this too we consider to be no longer tenable in the light of our results. Though the work of others, e.g., Warwick James and Hastings, had already undermined this hypothesis, even so we were surprised to find that only 6 children out of 1,033 were complete mouth breathers: and enlargement of the palatine tonsils was observed in approximately equal numbers of normal and post-normal children. There is however a definite association between post-normality and the habit of keeping the mouth open which still lacks an explanation. The habit may just as well be the result as the cause of the occlusion which our figures prove—as others have done—to have a fairly close association with narrow nostrils and palate. It appears probable that it was the open mouth which accounted for the more frequent enlargement of the superficial cervical glands we found in the post-normals; and it is common experience that the open mouth habit tends to disappear of itself in the course of years without special treatment, whereas the post-normal occlusion does not.

The most definite association we found was that between post-normality and the habit of sucking a digit with antero-posterior force; the defect was twice as common in children with whom this practice was habitual and, looked at strictly as a factor in malocclusion, the dummy is less harmful than the digit, however unfavourable comparison may be from other points of view. It would appear that this matter might well be the theme of a profitable discussion with the pediatricians who seem to hold no unanimous opinion on the operative factors governing this common habit of infancy. The evidence we adduce to show some association with mild hunger is suggestive though not convincing. At any rate this appears to be the only factor at which practical measures to prevent post-normality can be directed; though there are some who hold that sustained interference with such a habit produces psychologicial trauma.

Our examination of the parents and siblings produced some interesting results which deserve discussion. We point out that the undoubted familial incidence of post-normality is not conclusive scientific proof of its genetic inheritance; and we draw attention to other family influences which if not the primary cause may at least augment it. Though our observations do not prove the genetic transmission of post-normal occlusion they do not of course disprove it. And when the other published work is taken into consideration, its occurence in such a constant ratio amongst so many communities of European stock living under such diverse environments leaves little doubt in my mind that we are confronted, as Sir A. Keith long ago suggested, with a somatic variation of a genetic kind. It is only fair to say that Mr. Leighton is less certain: he is an orthodontist and in what follows I speak as a critic of your art and for myself alone. Recall the fact that in Anglo-Saxon England, human incisor teeth normally met edge to edge as they still do in many races. In some fifty generations this

occlusion gave place not only in Britain, but in other peoples of West European stock to the over-lapping bite we consider normal today, and no-one seriously doubts that this character is genetically transmitted. There are grounds for the belief that the same may be true of post-normal occlusions and the other characters associated with it—the narrow palate, the long pre-maxilla, etc. Consider some of the implications of this belief. Here we have a character of common occurence: no constantly adverse effect on health has been demonstrated, and those that have been claimed such as anterior gingivitis and inflamed tonsils are probably due not to the occlusion but to the open-mouth habit which can be cured independently of the former. We even ventured to suggest in view of the high incidence of post-normality in mothers (approximately 35 per cent in mothers of normal children and 45 per cent in mothers of post-normal children, compared with 23 per cent in girls generally) that the condition might carry advantages as well as drawbacks if to be more nubile is an advantage. There are some six million children in this country below school-leaving age and it is probable that about one and a half millions of them carry this character. In the face of these considerations are we justified in assuming, as many orthodontists do, that it is a character to be corrected by special treatment whenever possible ? Or is it perhaps in the same category as enlarged tonsils, the wholesale removal of which is still widely advocated in spite of growing scepticism as to the value of the operation ? If treatment is commonly provided for aesthetic reasons, what is the difference in principle between such provision and that of plastic surgery for all individuals whose noses or mammary glands fall outside certain standards regarded as aesthetically desirable ? These questions are deliberately provocative and I shall be interested in the discussion they evoke.

Mr. B. C. LEIGHTON

I AM GOING to deal tonight with three of the most important factors that are found to be associated with postnormality, and the speculation that they have stimulated in my mind. The first of them is the sucking habit.

The effects of sucking habits, are not always proportional to the amount of force put on teeth. Many Class 1 cases were found to have had vigorous sucking habits sometimes with great displacement of the incisors. On the other hand some Class II cases showed only displacement of the molar relationship as a result of these habits.

May I now say a word about the effect of the habits.

Many sucking habits are carried out in such a way that the force exerted on the teeth is vertical, causing usually an anterior open bite. That this effect is usually harmless may be confirmed by the high percentage of open bite cases seen at this age. We found 4.6% in the control group, and 11.6% in the postnormal group, and estimate that it would be found in about 6% of any random sample of children of this age; a far higher percentage than would be found in the permanent dentition.

The usual, and most damaging method adopted by these children was to insert the thumb in the mouth with the palmar surface applied to the palate and palatal surface of the upper incisors. Often the fingers of this hand are clamped across the bridge of the nose, pinching those parts lying between the nose and palate. Within the mouth the normal balance of pressure is upset. The pressure of the tongue on the palate, laterally on the lingual surfaces of the upper and lower cheek teeth and anteriorly on the lingual surface of the lower incisors is lost. In its stead the thumb presses upwards and forwards on the centre half of the anterior part of the

palate, the palatal surface of the upper incisors, and on the labial surface of the lower incisors. This pressure is greater than that of the tongue, even if only because of the weight of the arms.

The effects of pressure from the thumb are as follows:

(*a*) The upper incisors are proclinated, causing the increased overjet that we found.

(*b*) Because the pressure from the thumb is not evenly distributed over the whole width of the palate, there is a tendency for a narrow upper arch to develop, a factor that we found to be rather marked in some postnormal cases.

Once the postnormality is established, whether a sucking habit be present or not, lateral pressure from the tongue will tend to occur further back on the upper arch thereby favouring a persistence of the narrowness anteriorly.

(*c*) The effect on the lower arch of teeth is an antero-posterior compression, usually causing flattening of the lower incisors. We found that the spacing of the lower cheek teeth closed earlier in the postnormal cases. Because the mouth is opened more than would be normal at rest, the pressure of the tongue does not operate during sucking to so great an extent on the lower arch of teeth, especially the incisors.

There are many diverse methods adopted by children in these habits, most of which have been described very fully by Dr. Magda Haas before the European Orthodontic Society. In most cases the habit follows a definite pattern to which the child adheres. In the majority of cases the habit starts within a few days of birth, and was strongly established even at first. In many of those children who were free of these habits, efforts to induce them by use of a dummy or inserting the thumb in the mouth were repulsed violently.

I had the impression that frequently sucking habits are congenital. On the other hand we found some evidence that mild degrees of hunger early in life may encourage the adoption of these habits.

In examining the younger children of the samples I noticed that the effects of these habits manifested themselves very early in some cases, often before the completion of the deciduous dentition. This makes me wonder whether the direction in which the force is applied is the result rather than the cause of the relationship of the teeth. It is possible that an overjet of the upper gum pad over the lower causes the thumb or dummy to be inserted in a more vertical direction, and that where there is no overjet they are inserted more horizontally. If this be the case then the habit merely emphasises a pre-existing tendency, and may tip the balance between a slight deviation and a definite postnormal occlusion.

In support of this I have noticed a great variety in the relationship of the gum pads of those young babies that I have had the opportunity to examine.

In dealing with the habit of mouth breathing we found that 157 of the postnormal group and 125 of the control group showed an open mouth habit, but of these only 109 and 104 respectively were actually breathing through the mouth. (I should explain that all except six of these children breathed through their noses as well as their mouths.)

The remainder, 48 of the postnormal group and 21 of the normal group, showed failure of the anterior oral sphincter only; that is, they were not breathing through the mouth.

This difference is unlikely to be a chance one, and it is possible that failure of the anterior sphincter alone may tend to cause postnormality, whereas failure of both sphincters has no effect on the relationship of the jaws to each other.

May I put before you the following suggestion, which may account for this association.

When the anterior sphincter alone fails, the soft tissues of the floor of the mouth

are still drawn upwards and backwards and carry with them the mandible which seems to swing open slightly on the condyles without any forward movement under the eminentia. On the other hand, where both sphincters fail and leave a free airway there is a tendency for the soft tissues and the mandible to be thrust forward, carrying with them the condyle. Another noteworthy fact that we found was that, although the tonsils were enlarged as frequently in the control group as in the postnormal group, the cervical lymph glands associated with the tonsils were enlarged more frequently in the postnormal group. I should like to put forward another suggestion, which may account for this.

The fact that the mouth is open indicates poor tone of the muscles that support the mandible, and this may well be associated with incorrect or deficient drainage of the naso-pharynx. Where there is a free airway through the mouth, germ laden cold air is repeatedly passed over the surface of the bucco-pharynx and the tonsils themselves, causing both drying and infection of these tissues. In those cases where there is only failure of the anterior oral sphincter there is no passage of infected air over the pharynx and tonsils, but there is still poor drainage of the naso-pharynx, manifesting itself as an enlargement of the cervical glands.

Now I shall turn to the familiar factor (or hereditary factor, as Professor Humphreys believes it to be).

We have attempted to collect some figures on the incidence of postnormality in other races than our own, so that we may compare its racial incidence.

Of 28 Hindu skulls, Milo Hellman found 18 per cent were postnormal.

Leigh states that normal mesio-distal relationship of the molars is the rule in American Aboriginees.

Miss V. H. George diagnosed four out of ten Maori skulls as being postnormal.

Norman Bennett suggests that postnormal occlusion among the Chinese skulls in the Royal College of Surgeons Museum is so frequent that it may be a normal condition to them.

Arne Bjork gives the following figures for Swedes:

Of 322 boys of 12 years of age, 18.9 per cent were postnormal.

Of 281 conscripts of 21 to 23 years of age, 16 per cent were postnormal.

He also quotes Seipel as giving the figure of 15 per cent.

It is also significant that the incidence of pre-normality in these groups was 2.3 per cent, 9.3 per cent and 3.3 per cent respectively.

We found that of 3,380 children, 25 per cent were postnormal, which is almost the same as that found by Ainsworth in this country, and Angle in America.

During the course of this survey 37 pairs of twins were examined, and of these 27 individuals were postnormal (36 per cent). The association of postnomality was very slightly stronger (4 per cent) between the twins than between brothers and sisters of different ages. I realise that the numbers are small, but if postnormality is frequently hereditary, I should expect to find a much stronger association between the twin pairs.

Comparison of Incidence of Postnormality among Siblings and Twins.

Children examined.	Incidence of Postnormality among: Twins	Siblings
Normal occlusion	27%	19%
Postnormal occlusion	52%	40%
Difference between percentages	25%	21%

We found more postnormality among boys than girls, thus confirming the findings of Ainsworth. The explanation of this is made difficult by the fact that fewer boys than girls developed sucking habits.

Professor Humphreys has suggested that postnormality is an hereditary character. We did admittedly find a familial tendency, but it showed an unexpected pattern. An

explanation of which we have suggested in our original text.

I feel I should emphasise that whereas the pattern of size and shape of the jaws, and their relationship may be inherited it is probable that factors which produce postnormality may also be inherited. One that comes to mind immediately is thumbsucking. We did not obtain any histories of sucking habits in the parents, because they would have been very unreliable, but we did find that postnormal parents tended to have children with sucking habits, although the tendency was not sufficient to be claimed as significant.

There are three ways in which an hereditary factor could be transmitted:

Transmission of jaw size and form.

Transmission of factors causing postnormality.

Transmission of a susceptibility to those factors.

Our findings may be summed up briefly: there are some factors present after birth, which are associated with postnormality. Chief among these are sucking habits. Whether they cause postnormality, or are effects of it, cannot be shown by statistical methods, but they almost certainly emphasise the condition. There is no doubt that a familial tendency is present, but how is is transmitted is open to speculation.

Discussion

The President said that he remembered the late Mr. A. T. Pitts putting forward in an after-dinner speech the proposition that a certain degree of postnormality was a considerable asset in the marriage market, but he had not expected to hear that theory and its implications raised at a scientific meeting of the British Society for the Study of Orthodontics.

Professor Humphreys and Mr. Leighton had shattered in their paper one of the ideas on which he had relied in the past. He had been in the habit, for a number of years, of advising the substitution of a dummy in cases in which the practice of thumb-sucking and finger-sucking could not be stopped in infancy, and he had maintained—he thought correctly—that there was no evidence to show that the use of a dummy caused any damage. That satisfactory state of affairs had now been shattered, but he thought Professor Humphreys would probably agree with him that the dummy was less dangerous than the thumb.

Miss L. Clinch said that the investigation reported in the paper was certainly of great interest to orthodontists, and she had no doubt that Professor Humphrey's opening remarks would be considered provocative, as he meant them to be.

She would like to congratulate Mr. Leighton on this work. She knew how carefully he had done it and the amount of time that he had devoted to it, and she knew he would not mind if she criticised the paper.

At the end of the paper as published in the *British Dental Journal*, the authors very kindly acknowledged that her advice was sought before the investigation started, so she would like to make it clear that she had advised first, that models of the children should be taken and second, that the stage of development investigated should be after the eruption of the first permanent molars. She still felt that the weakness of the investigation and of any conclusions drawn from it lay in the fact that no models were taken, the diagnosis having been carried out by visual examination only, and in the fact that the present knowledge of the normal for the stage of development examined was less than that of any other period of the dentition.

If models had been taken there would now be a permanent record of the work done which could be used in future investigations and would, she thought, be of great value. It would also be possible

to check the accuracy of the diagnosis of the cases. Recently she had asked Professor Friel if, when he had charted a visual diagnosis of malocclusion and later compared that with the models, he had ever found that his original diagnosis was incorrect, and his reply, put briefly, was "often." As Professor Friel was an authority on occlusion, she hoped that Mr. Leighton would not think that she was being unfairly sceptical about the accuracy of his observations.

With regard to the stage of development chosen for the investigation, it was agreed in the paper that the position of the mandible relative to the maxilla was not constant between two and five years of age and that the mandible moved forward in relation to the maxilla during this stage of development. It had been shown by Professor Friel, Dr. Northcroft and others that in the normal relationships of the earliest stage of the complete deciduous dentition the distal surface of the upper and lower second deciduous molars were flush, but it was obvious that if that condition persisted the first permanent molars would be forced to erupt into postnormal occlusion. Therefore what was normal at two or three years of age was postnormal at 5 years of age, yet, as far as she could understand, in the investigation under discussion the criteria applied to the 3 year olds were the same as those applied to the 5 year olds.

She had recently been taking serial models of about one hundred children 2 years of age up 6 or 7 years of age. The incidence of malocclusion appeared to be high in the younger children but as development proceeded she found that the malocclusions tended to correct themselves. She thought there were two explanations for this. First, a habit might cause a malocclusion which would correct itself when the habit ceased, and second, some cases of postnormal mandible in the early deciduous dentition were due to delayed development which was only temporary. That was another reason why she thought that the period chosen by the authors was an uncertain one on which to base a large investigation.

She would now like to comment briefly on some of the remarks made by the authors in giving a résumé of the paper.

With regard to sucking habits, amongst the children of whom she had been taking serial models she had found that there was not one with normal occlusion while the sucking habit persisted. She did not know how soon sucking habits started, but she must have examined about 1,000 infants under ten days old, and she could not remember seeing one sucking either finger or thumb at that age, but she had not been examining the children to observe this so it was only her impression.

She could add some information on one race to that given by Mr. Leighton. In models of 162 Australan aboriginies in the Royal College of Surgeons' Museum, nine had postnormal occlusions of the mandible, so far as could be judged from models alone.

Professor Humphreys had stated that in Anglo-Saxon England human incisor teeth normally met edge to edge as they still did in many races. She had discussed this with Sir Frank Colyer and he was emphatic that in animals and in man edge-to-edge occlusion is an acquired bite, that it comes with wear and is present as a rule only when there is marked attrition of the teeth. Certainly in the Australian aborigines edge-to-edge occlusion of the deciduous incisors was found as the first permanent molars started to erupt, and again it was found in cases in which the third molars were in occlusion but not in the earlier or intervening stages.

Personally she was doubtful whether 25 per cent of postnormal occlusions would be found in 1,000 unselected girls and boys with permanent dentitions who had not lost any teeth prematurely. In the

B.S.S.O. Report on Postgraduate Education the Committee's opinion was that the incidence of malocclusion of all types needing protracted treatment was 5 per cent.

Professor Humphreys seemed to consider that postnormal occlusion was treated for aesthetic reasons only, but there were two much more important reasons for its treatment. The first was to improve general health; it was often surprising how a child improved in health after intermaxillary traction had been worn for some months. The second reason was that much mental misery could be caused by a malformed mouth; it was not unusual for a parent to be anxious to have a child's mouth treated simply because he or she suffered so much psychologically from a similar malformation.

She thought that it had been the general teaching among orthodontists for many years that there was no evidence that bottle-feeding affected the dentition, at least where the correct teat was used. The results of the present investigation confirmed that teaching, as obviously the mothers who sought advice at a welfare centre would be likely to use the bottle in the correct way. The work of Mr. Warwick James and Mr. Somerville Hastings published in 1932 made it clear how rare true mouth-breathing was and that it was incorrect to assume that because the mouth was kept open at rest breathing was taking place through the mouth. That also was confirmed by the present investigation.

In a letter to her last week Professor Humphreys had told her that he was going to be deliberately provocative, so she hoped he would forgive her for being provoked.

Professor M. A. RUSHTON said that the investigation carried out by Professor Humphreys and Mr. Leighton with the support of the Medical Research Council was clearly of great value and interest. In the first place, it gave information about the incidence of abnormalities in a certain age group in a certain locality, and this information on the whole supported that derived from other sources and extended it. When it was found that approximately one-quarter of the children were judged to be postnormal (it might be that this postnormality was not quite the same thing as some orthodontists considered post-normality to be, but nevertheless it was an entity), it must be concluded either that this was a profound social or genetic evil or, on the other hand, that it was a normal variation of the British race, as Professor Humphreys indicated was his view.

If it is a social evil with an economic basis, one would expect that to have been demonstrated, but the difference between financially differentiated groups was only slight and it was not said that it was significant.

There was no statistical evidence that postnormality was related to disease in infancy or to inferior diet after weaning. That seemed to him to be an extremely important negative observation, as both those could be reasonably regarded as likely causes.

The next point seemed to him to be of interest, namely, the fact that the postnormal children concerned in the investigation were consistently lighter, although more prone to eat hard food. That would suggest that postnormality and lightness of build were parts of a single developmental pattern and that the latter was not the consequence of the former; but recently Miss I. Allen had analysed the X ray measurements of Woollard and Garrow and had found that in postnormal boys at 5 years all measurements were greater than in normals and that they were above the average in physique and more advanced in bone age. She went on to suggest that the difference in growth between normals and postnormals consisted of greater early growth in postnormals, followed by relatively slower growth from five years onwards, when the greatest impetus in normal growth was found in the lower half

of the face. Smyth and Young, he believed, also found that postnormals were taller at all ages than normal children. There was thus a most important conflict of findings.

The rather contradictory findings in connection with illness in pregnancy were of doubtful interpretation and he would like to see this matter investigated again elsewhere if the opportunity arose.

The section on labour was substantial evidence that neither prematurity, presentation nor obstetric difficulties were concerned. That also, he thought, was a most important negative observation. The health of the mothers during breast feeding of 20 weeks or more, however, was significantly worse in the post-normal group, so that a nutritional factor in very early infancy was not yet ruled out.

The smaller alae nasi in postnormal children and the more frequently open mouths might well be simply another part of the same abnormality of which the jaws were an expression, and not either casual or consecutive. The more frequently open mouths day and night, he agreed, could be responsible for the more frequent enlargement of superior cervical glands.

It was an impressive observation that more postnormal children used dummies and used them longer, but, before concluding that the use of dummies was one of the causes of postnormality, one must eliminate the possibility that an existing malrelationship of the jaws and difficulty in closing the lips might give rise to a discomfort which the dummy relieved.

The analysis showed that significantly more postnormal children sucked in such a way as to exert an antero-posterior force on the jaw, but that did not prove that such sucking caused the deformity, as Mr. Leighton had admitted in his remarks. If, for example, a postnormal deformity was already present from some other cause, sucking would, from the nature of the deformity, be more likely to produce an antero-posterior force. What had been shown in fact was merely that, among children who sucked, a postnormal deformity was likely to be associated with an antero-posterior force, and the direction of the force was as likely to be the result of the deformity as the deformity to result from the force. That each factor should increase the effect of the other, as suggested in the paper, seemed likely, but it could not be regarded as established that sucking habits were a cause of postnormality.

The observation about tooth spacing was valuable in that it showed that the growth abnormality concerned not merely growth at the condyle or sutures but also growth of alveolar bone to an important extent, including the movement of teeth through and with the bone. While a narrow arch could probably be the result of failure of growth at sutures, lack of spacing could not be.

Incidence of postnormality was higher in the parents of postnormal children than in those of normal children, and still more in siblings. The suggestion in the paper that this was not due to genetic causes but to environmental ones seemed to him to lack any adequate support. The difference between the position of the fathers and mothers could be due to the limited numbers of fathers available and was not an argument against the importance of genetic factors, nor indeed was the well known tendency of human beings to imitate one another. He was glad to hear Professor Humphreys express his belief in the importance of genetic factors.

He thought that the great value of the paper was that it had cast great doubt upon a number of suggested causes of a deformity. He, for one, was left with a picture of a condition which might be of genetic origin, which was not strictly localised to the jaws but might include general physical and even psychological characteristics, and which had been shown to be aggravated by various environmental factors. If the abnormality could be produced solely by environmental factors that had still to be demonstrated.

In addition to many solid conclusions in the paper, the authors in their talks that evening had put forward some very interesting speculations based on the figures obtained in the investigation, and it was right that all possible interpretations should be discussed. It should be remembered, however, that if statistical methods of investigation were used (as had been done in the present case) one must absolutely refrain from drawing conclusions from any of those differences which had not been shown to be statistically significant, whatever tempting indications they might appear to suggest.

Mr. HAROLD CHAPMAN said he thought that a great deal of credit was due to Professor Humphreys and Mr. Leighton. When they spoke of postnormal occlusions, was not it indicated in the paper that they were speaking of marked cases of Class II, Division 1 ? One did not see one person in four with this condition, and he was inclined to agree with the statement in the Society's Report on Postgraduate Education to which Miss Clinch had referred, that the proportion of children who needed orthodontic treatment was only 5—10 per cent. Therefore the proportion of cases of postnormal occlusion which required treatment was less than 5 per cent. It must also be remembered that postnormals were of various kinds, and there were some (he had seen two quite recently) which one might think were normal if one did not examine them. As Miss Clinch had pointed out, it was extremely difficult to make an accurate diagnosis at so early an age as 2—5 years unless the case was very marked. He believed that one of the first papers that he had presented to the Society in 1910 described a case of normal occlusion which at 4 years of age was postnormal as far as the relation of the canines was concerned, but this was only a developmental phase which is common at 8 or 9 years of age the canines were normal or even slightly prenormal. Again, Miss Clinch herself had carried out an investigation of a large number of children 1—5 days old and showed (he thought conclusively, and he used the paper a good deal in teaching), that postnormality existed at that age quite clearly.

He thought that the authors rather belittled their work when they said that the results were negative. He did not regard results as negative if they knocked down some ninepins which had been standing in front of orthodontists for a number of years. It seemed to him that the sooner those ninepins could be eliminated from the textbooks the better it would be for orthodontics, and he therefore regarded as extremely valuable the results which the authors called negative. They confirmed what some orthodontists had believed but for which they had not the evidence.

In regard to Class II, Division 1, cases, Professor Humphreys had said that he was not clear why the mouth was open. It seemed to him that, when the upper and lower incisors were so far apart that there was an overjet of 8—10 mm., the individual could not bring his lips together without a marked conscious effort and he would therefore have an open mouth. Professor Humphreys might have in mind other types of Class II cases, where there was no overjet, but he thought that in a typical Class II, Division 1, case of a severe type it would be remarkable if the mouth was not open. The degree of overjet had a more important bearing on the open mouth than the postnormality.

In connection with the keeping of the lips apart, Mr. Leighton had referred to lack of muscle tone. Was there a lack of muscle tone because the lips were apart? He supposed that Mr. Leighton was referring to the tone of those muscles which held the jaw up. If the lips were apart, was the free-way space enlarged, and, if the free-way space was enlarged, what was the effect on the muscles? Were the muscles made longer? It seemed to him that that problem was involved in the question

of the open mouth.

He believed that Miss Smyth, in her investigation of skulls a thousand years old at Bradford-on-Avon, found that they showed all the types of malocclusion which existed to-day, and he would like to ask Professor Humphreys whether he thought that the edge-to-edge bite existed from birth and had existed for thousands of years.

Many of the points which he had intended to put forward had already been mentioned, but, with Professor Rushton, he would like to ask what was the evidence that the sucking habit produced postnormal occlusion, as appeared to be indicated in the paper.

With regard to the percentage of postnormality increasing with age, that seemed to be in accord with what parents frequently said, but he had never believed that it was so. He had thought that some factor in the proportional growth of the face made the postnormality appear worse, but it was interesting to know that the authors had shown that it increased with age. He understood that the authors were referring only to 2—5 years of age, whereas he was thinking of considerably older children.

He very heartily congratulated them on their excellent work.

Miss K. C. SMYTH said she would like to join in thanking both Professor Humphreys and Mr. Leighton for their work. She felt that the subject with which they had dealt had been very well ventilated from every possible point of view. She wanted to mention three matters in particular, which had been referred to by previous speakers.

The first was her work on the Anglo-Saxon skulls, to which Mr. Chapman had referred. She had done that work at the home of the investigation under discussion, namely, Birmingham, many years ago, when Professor Brash was Professor of Anatomy there. He had shown her the skulls and had written a foreword to a paper which she had published on them. She had found every type of abnormality in those Anglo-Saxon skulls, including a number of marked postnormal occlusions with all the associated conditions seen in such cases to-day.

The other point to which she had intended to refer was the question of the psychological reasons for the treatment of abnormality, to which Miss Clinch had referred. In these days, when there was so great a demand for orthodontic treatment and such a small possibility of supplying it, in other words, long waiting lists at all clinics where the treatment was given, she gave preference to the cases in which the children themselves asked for the treatment. It was quite astonishing to find in how many cases this was so, because the children felt the abnormality from a psychological point of view.

The third point which she had wished to mention had been referred to by Professor Rushton, namely, that the postnormal children whom she had investigated some years ago, and on whom a report had been published under the Medical Research Council, were definitely taller than the normal children in the same age groups, their weight being about the same. Sir Norman Bennett had been convinced that postnormal children were also more intelligent than children with normal occlusion, and, that having been impressed upon her by him when she was a student, she had borne it in mind at the time of her investigation. Although no notes were taken of the school records of the children in that investigation, she had definitely obtained the impression that they were brighter and more intelligent than the average child of the same age. It seemed that some physical disabilities had a compensation provided by Nature.

With regard to sucking habits, she would like to ask the authors of the paper whether they had made any notes about the effect of the sucking upon the digit. She supposed that the thumb was broader and

stronger and therefore less easily influenced by the twisting that sometimes occured, but some children twisted their fingers as they sucked them, and she had had two cases in which the first finger had been twisted round so that the nail lay against the central finger. That showed, she thought, the tremedous force that was exerted by the child. In both those cases the deformity of the mouth was very marked indeed.

Mr. C. F. BALLARD said that he, with a few other people, had been working on the subject of muscle pattern for some years, particularly in relation to mouth breathing, and he would like to congratulate Professor Humphreys and Mr. Leighton on producing statistical proof of many of the facts of which he and his colleagues had been certain from clinical observation.

He found it rather difficult to discuss the paper, because he divided muscle pattern into several types, but there were one or two points that he would like to mention.

First, the typical open mouth posture associated with a Class II, Division 1, occlusion, he thought was not the result of lack of tone; it was an inherited posture, and he thought not always related to an abnormal skeletal pattern; in other words, one gene complex produced the skeletal pattern and another gene complex produced the lip pattern. These people had normal tone in their lips with their lips apart, and they acquired the habit of keeping their lips together not by increasing the tone of the orbicularis so much as by contracting the mentalis muscle and lifting the lower lip up to the upper lip. That was a new muscle pattern, which had to be acquired, as a rule, by a conscious effort.

Another abnormality of muscle pattern of the lips, which produced a typical Class II, Division 1, incisor abnormality, was that which was frequently associated with the sucking pattern but which might not be related to it at all, namely, the abnormal swallow. It could produce a Class II, Division 1, incisor relationship, which might not be related to a postnormal occlusion. The postnormality, in these cases, he thought, was dependent on the size of the dentition to the apical base; in other words, if a Class II, Division 1, incisor relationship was produced, the maxillary buccal segments might or might not come forward.

He personally was convinced that there was a good deal of evidence—admittedly it was clinical evidence—for the muscle patterns being definitely inherited. Many of the sucking patterns were in the tongue, and there was nothing that the child could imitate. He could not imagine a child imitating an abnormal sucking pattern of the tongue or a swallow of the parents, but if these abnormalities were investigated in relation to abnormalities of the parents it was often found that one or other of the parents had an abnormal swallow.

With regard to the free-way space in the open mouth postures he was inclined to agree with Mr. Chapman. He had taken some radiographs of free-way spaces, and he agreed that the open mouth posture was not due to lack of tone of the muscles supporting the mandible. There was no increase of the free-way space and it was not correlated with the skeletal pattern.

Mr. W. J. TULLEY said that he would like to congratulate Professor Humphreys and Mr. Leighton on their excellent investigation.

With regard to muscle pattern, it was not known definitely whether that itself was genetic or to what degree it affected the dentition.

He thought that the children who were prone to sucking habits should be subjected to a cinematographic analysis over a period, as had been done in America. That was a very valuable aspect of research which had yet to be undertaken fully in this country.

Miss Clinch had said that she did not think the sucking habit started in the first

few days of life, but he believed that some authorities said that sucking was actually carried out *in utero*.

With regard to Professor Humphrey's provocative remarks about postnormal occlusion, he himself had been suffering considerably from ulceration of the lower lip in the last few weeks, and he wished that somebody had done something about his postnormal occlusion in his youth. His occlusion was postnormal, and he was not very light and not very tall, and he did not think that he was very intelligent.

Mr. A. J. WALPOLE DAY said that he greatly admired the work which Professor Humphreys and Mr. Leighton had done.

He had hoped that they would produce some evidence that birth and pregnancy might show some relation to postnormal occlusion and that there was a greater degree of postnormality in first-born children. According to the figures, there was nothing conclusive about that.

The criteria which the authors used allowed for half a cusp of variation, and it was stated in the paper that normal occlusion extended up to a cusp-to-cusp relationship, and then quite suddenly, for no reason whatever, the authors said that if a cusp-to-cusp relationship existed there was no reason to believe that this might deteriorate. He always felt that there was a very strong reason for believing that it might deterioriate. It appeared from the paper that the incidence of postnormal occlusion became greater as the children grew older, whereas he personally thought that it always became less. It might be that some of the cases in the younger children which the authors thought would not deterioriate had in fact deterioriated later on and caused a slightly higher postnormality in the older age groups.

Miss Clinch had said that she wished the authors had taken models of the cases they had investigated, that would have been a stupendous task. He would like to make a plea that orthodontists should try to understand what they meant by postnormal occlusion. They might think that it was only a postnormal mandible and forget that there were cases of prenormal maxillas which gave a similar result.

Mr. R. B. DOCKERELL said that he would like to thank Professor Humphreys and Mr. Leighton for their very comprehensive paper. He particularly liked the form of the questions which they had asked, which covered the whole field without being of the type which wouldmake the average mother quail.

The authors stated that the inquiry in question was a large-scale inquiry into the aetiology of postnormal occlusion in children of 2 to 5 years of age. As he understood it, aetiology meant causation, and a planned statistical inquiry on the basis in question could give the investigators the associations or lack of associations but could not tell them the causes. It was a very good groundwork on which to found a later work on the aetiology, but nowhere in the paper was there proof of the cause or causes of postnormal occlusion. Unfortunately the authors said in the summary in their paper that great force was necessary to produce postnormal occlusion in connection with sucking habits, and he thought it was dangerous for that statement to appear in the summary, because now-a-days the summary was the only part of a paper which many people read and they might conclude, from reading this statement, that it was proved in the paper that sucking habits caused postnormality instead of merely being associated with it. If causations were inferred from the tables given in the paper, the most amazing results could be obtained. It could be proved, for instance, that a severe illness in early pregnancy practically ensured that the child would not be postnormal and that there was a strong probability that a postnormal child would be male.

Dr. M. A. TISCHLER said that he had never thought it would be possible to prevent the development of malocclusions

by prophylactic measures. He had been surprised, in examining the skulls of newborns, to find how often abnormality was pre-formed.

Mr. B. C. LEIGHTON, in replying to the discussion, said that he wished to thank Miss Clinch, Professor Rushton and Mr. Chapman for their kind remarks and also for their criticisms, which gave him an opportunity to explain some of the shortcomings of the research in question.

With regard to Miss Clinch's question why models had not been taken, he would say that the reason was largely economic. The children examined were taken to the clinics voluntarily by their mothers, who were usually in a great hurry. A certain amount of difficulty had been experienced in persuading the mothers to let themselves be subjected to questioning, and he thought that many of the mothers would not have agreed to stay while models were taken. Secondly, it was necessary for a work of a statistical nature to be based on a certain minimum number of cases, and the Statistical Department in Birmingham estimated that the inquiry would be useless with less than 500 children, even if models were taken. To take models of all those children as well as collecting all the necessary data would have been too great a task.

With regard to the age of the children, children of pre-school age had been chosen because in Birmingham they were readily available and at that age histories, especially early histories of thumb-sucking habits, pre-natal conditions, and so forth, were much more likely to be accurate. Many of the facts in the histories were already recorded by the local health authorities and were readily available. As soon as the children went to school, those histories were either filed and put away in the cellars of the county hall or destroyed. He believed that during the war most of such histories had been destroyed, so that for the school children there would have been no accurate records available.

Miss Clinch had pointed out that the diagnosis of postnormality was difficult. It had caused a good deal of worry in the investigation, and it had been decided to set a mean standard for all children between the ages of 2 and 5 years. It would have been very complicated to have a different standard of diagnosis for each age group, and he was sure that if there had been different standards doubt would have been felt about his ability to record them. Having one standard meant that if an error was made it was made for all the children in the same direction. In order to ensure that this should not affect the results, the age distribution in the two groups had been made the same.

With regard to bottle-feeding and the idea that it produced unhealthy children, during his examination of the children and the questioning of their mothers he had found that a large proportion of the bottle-fed children were bottle-fed because they were ill. Immediately a child or its mother became ill the child was put on the bottle. The result was that all the unhealthy children of that age were put into the bottle-feed group and if a child was breast-fed it usually meant that there was not anything wrong with it.

With regard to Professor Rushton's remarks, there was no statistically significant difference in the results as between the different social classes.

The heights and weights of the children had purposely not been emphasised, because they had been taken by different individuals at the different clinics and he felt sure that, with children of the ages in question, they would be open to a certain amount of doubt. He certainly would not pit the figures against those of Miss Symth, who he believed took the heights and weights herself.

With regard to the open mouth habit, to which Mr. Chapman had referred, what he had said about that was only a conception of his own and there was no

proof of it. It had been found in the investigation that the method of swallowing in the postnormal children was more frequently infantile in character, but that was not emphasised in the paper, because of the difficulty of diagnosing it.

Professor Humphreys and he had been assailed for claiming a causative association of postnormality with sucking habits. As had already been pointed out in the course of the discussion, a statistical analysis did not give the cause of the condition; it gave association only. Any piece of research of the type in question needed to be introduced by a statistical survey to clear the ground, and that had to be followed by experimental research of a more practical nature to establish the cause of the associations that were found. That research had not yet been done.

It seemed to him that postnormal children were not only more intelligent than others, but also decidedly happier.

No notes had been taken of the effect of sucking habits on the digits; it was only the way in which the digit was inserted in the mouth that was recorded. Calluses were frequently seen on the thumbs.

Mr. Day had referred to the number of postnormal children who were first-born children, and in that connection he could give two figures. The proportion of postnormal children who were first-born children was 47.8 per cent., and the proportion of children with normal occlusion who were first-born children was 52 per cent. That, he thought, was the reverse of what Mr. Day expected.

As to differentiating between superior protrusion and inferior retrusion in the children, it was very difficult to do that visually. They were so puffed out with fat that one could hardly see the bones at all, and he thought that the only effective way to make this differentiation would be by radiographic cephalometry.

The prenormals had been included originally in the hope that there would be found in them a diametrically opposite set of factors to those found in the postnormal group. Needless to say, that had not been the case, and the number of prenormals was unexpectedly small. He agreed that perhaps they should have been removed before the original paper was printed, but some of them were interesting. None of the prenormals was born by Caesarean section, but some of the normals and some of the post-normals were born in that way.

Professor H. F. HUMPHREYS, in replying to the discussion, said that the possibility that postnormal children were more intelligent than normals was one that had been mooted on many occasions, but in the investigation in question it had been a matter of subjective impression, so the evidence was of very little value.

He himself was not an orthodontist and his knowledge of orthodontics was that of an outsider, but the impression which the investigation and the discussion that evening had left on his mind that there was a hereditary element concerned (whether of muscle balance or of bone formation there was not sufficient evidence to show) and that it was the sucking habit that made the difference between a condition which was anatomically abnormal but was not sufficiently marked to be a cause of disability to the individual concerned, and therefore did not need any treatment, and a condition which did require treatment. That was why it was so important to obtain more information on the subject of what caused the sucking habit and how it could be modified, whether by oral screens or in some other way. He believed that the ill effects on health were not due to the post-normal occlusion but were due to the open mouth, and the evidence found by Mr. Leighton strengthened that belief.

He was sure he was speaking for Mr. Leighton as well as for himself when he said how much they had enjoyed the discussion and how grateful they were to the members for their criticisms.

On the motion of the President, a vote of thanks was accorded to Mr. Glass, Professor Humphreys and Mr. Leighton, and the meeting then terminated.

Simplified Crozat Type Appliance using Stainless Steel

By Norman Gray, h.d.d., l.d.s.

The demonstration aims to show that many of Dr. Crozat's principles for radial expansion for which he used gold wire can also be carried out with stainless steel technique using acrylic as the cementing medium in place of gold solder.

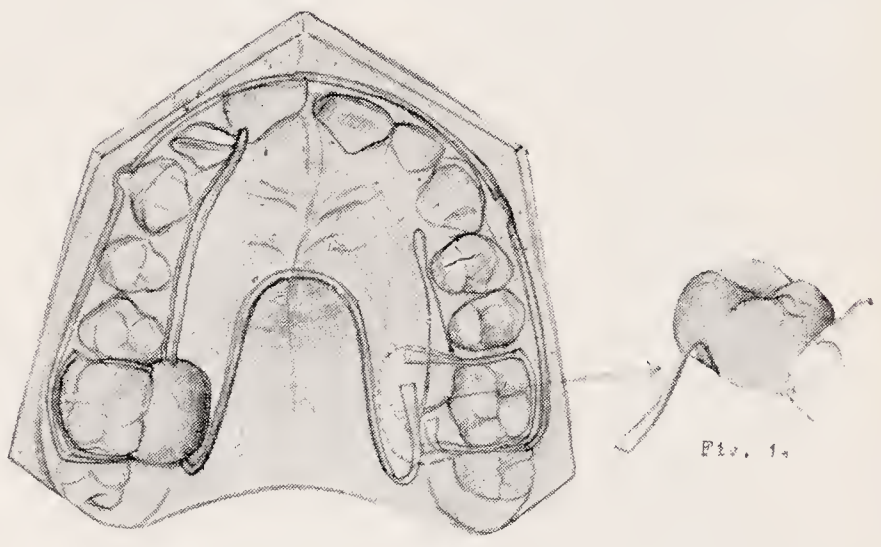


Fig. 1a

Fig. 1

The cribs are used different, of course. In this case I have employed the Visick pattern with lingual cleats.

In *Fig.* 1 the appliance has been shown without the plastic on the left side so that the insertion of the wires can be better understood.

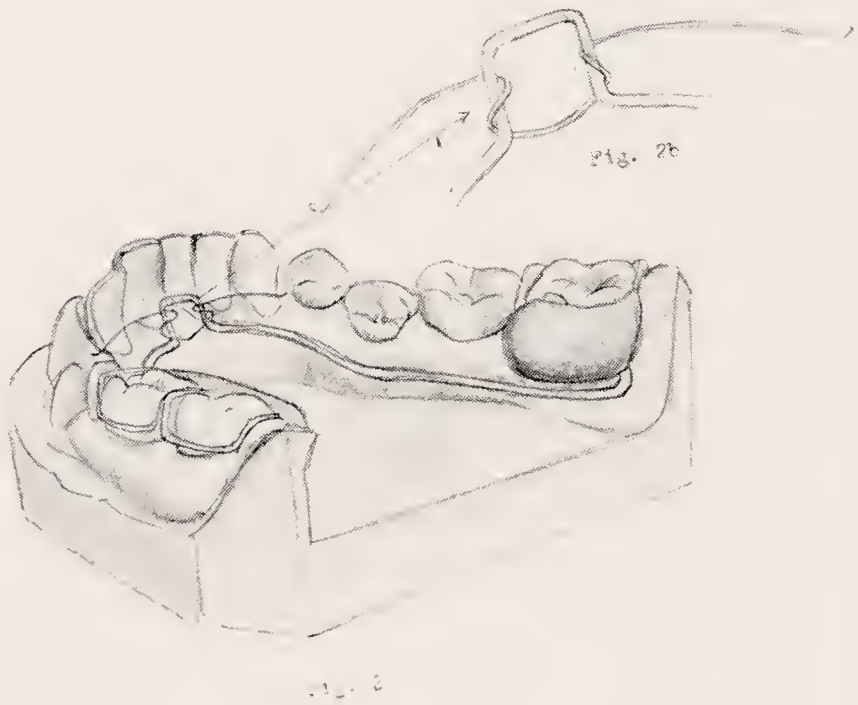


Fig. 2b

Fig. 2

Fig. 2 shows a simple method of adding finger springs as and when required.

A Demonstration at the meeting held on 8th May.

The Adaptation of Stock Pliers for Orthodontic Use

By J. H. Gardiner,* B.D.S. (Manc.)

The orthodontist may at some time wish to modify some existing design of pliers in the dental workshop. Very often this can be done with a carborundum stone, but a major alteration will involve heat treatment of the steel.

The stock pliers can be snipe-nose, round-nose or flat-nose, and those most suited to orthodontic use have a " box-joint " (*Fig.* 1), as these are less likely to work loose than the cheaper " lap-joint " (*Fig.* 2). The length of pliers for ordinary

FIG. 1

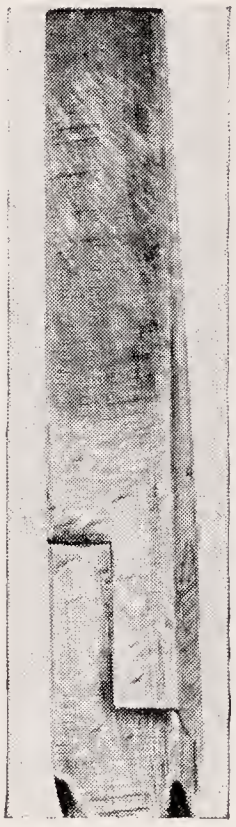


FIG. 2

wire bending can be 5 inches or $5\frac{1}{2}$ inches according to the size of the operator's hand.

On purchase, the stock pliers will be in a hardened condition, so to facilitate filing, the jaws are softened by heating to a dull red (825°C. or 1517°F.) and cooling slowly in the atmosphere. In

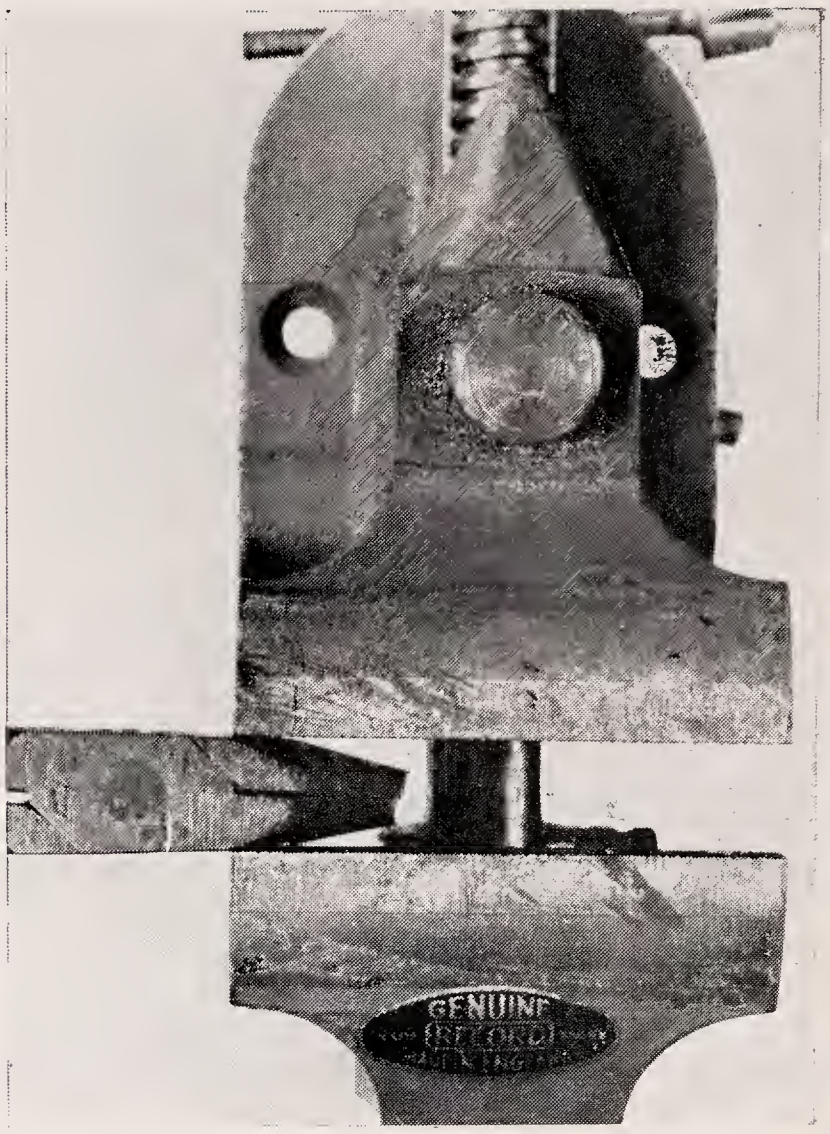


FIGURE 3

order to increase the purchase of the pliers when bending wire, it is an advantage to reduce the length of the jaws to half an inch. Any gap at the base of the jaws can be closed in a vice as shown (*Fig.* 3) whilst the pliers are red-hot.

Loop-forming pliers with a " stepped " jaw (*Fig.* 4) can be made from round nose blank pliers. $2\frac{1}{2}$ mm. of the end of each jaw can be reduced in the stages shown in cross-section in *Fig.* 5 with either a fine dental file or a flat metal file having one safe side. As with most pliers, the contacting surfaces of the jaws must not

*Lecturer in Orthodontics, University of Sheffield.

A Demonstration at the meeting held on 8th May.

FIGURE 4

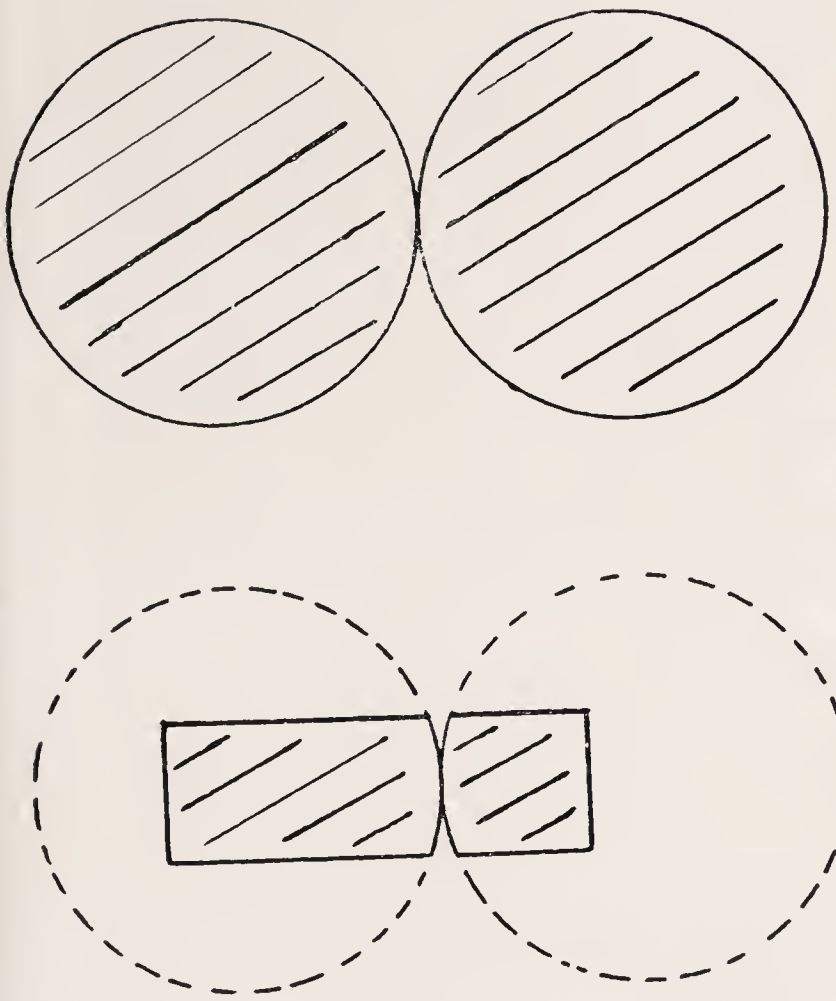


FIGURE 5

FIGURE 6

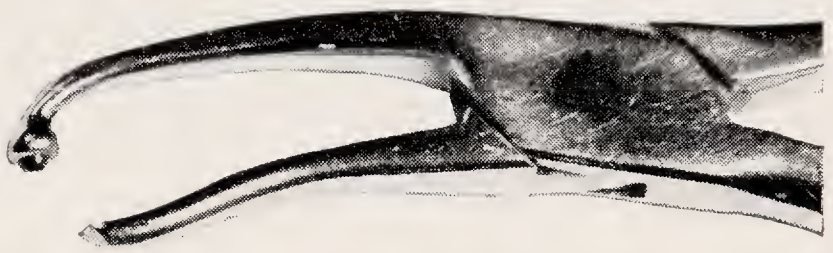


FIGURE 7

FIGURE 8

in any way be reduced. Having completed this terminal $2\frac{1}{2}$ mm. the next " step " can be formed. Useful diameters of these " cylinders " are 0.9 mm. and 2.5 mm.

Watkin pliers (*Fig.* 6) are made from snipe-nose blanks. The jaws are tapered down to about $\frac{1}{8}$ inch at the point on a coarse carborundum lathe wheel, and the edges bevelled with a fine half-round dental file until round in cross-section. The coincident grooves near the end of the jaws can be cut with a slowly revolving No. 1 cross-cut fissure bur.

Long round-nose blanks are used to make the band removers illustrated in *Fig.* 7. Whilst red-hot the jaws can be bent into the desired shape and after

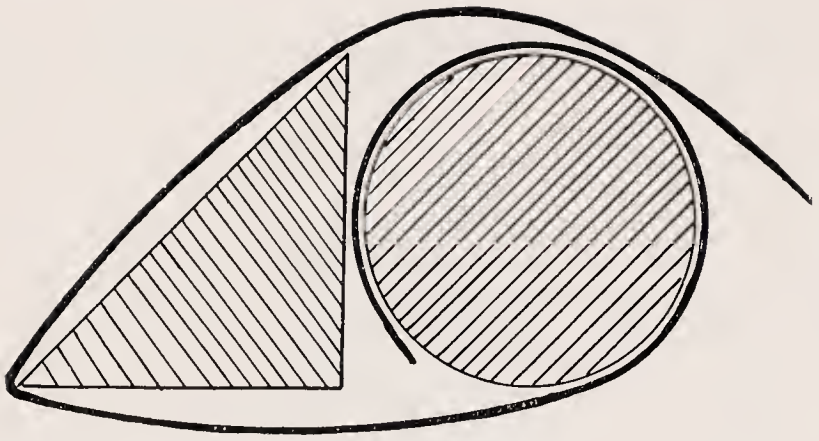


FIGURE 9

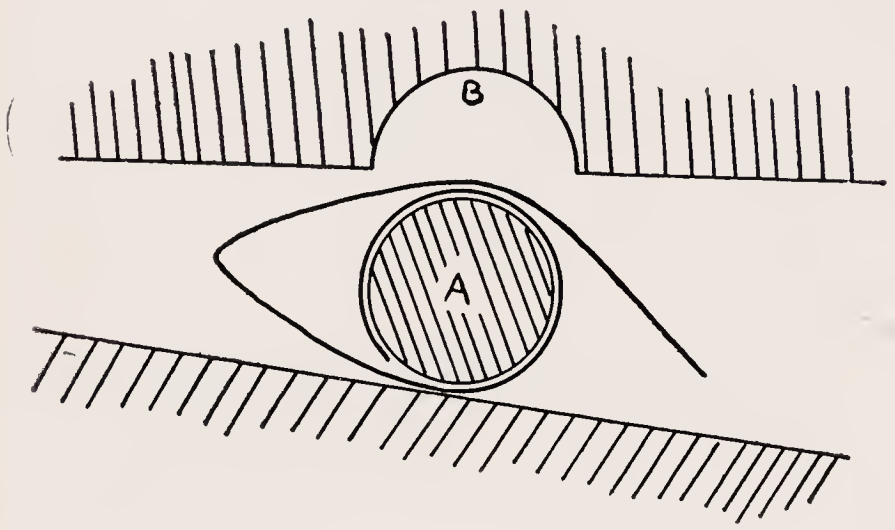


FIGURE 10

polishing a hexagonal steel nut can be brazed on to the longer jaw to make a receiving cup for the lead shot which will protect the tooth surface.

In making the modified Selmer-Olsen tube formers (*Fig.* 8) 6 inch snipe-nose blank pliers are used. The terminal 5 mm. of the jaws are reduced according to the size of the tube required but one jaw should be round and the other triangular in cross-section (*Fig.* 9). Stainless steel wire of the desired diameter is made into the lumen former (A) and is attached by a screw to one jaw as in the Tischler pliers. The groove (B) is cut with a fissure bur (*Fig.* 10).

The hardening treatment of all these pliers is carried out in two stages after they have been polished with carborundum stones, emery discs, pumice etc.

In the first stage, the jaws of the pliers are heated to a *bright* red (850°C. or 1,560°F.) and immediately, plunged into a heavy oil such as whale oil or motor car oil. This makes the steel very hard and brittle, so it is now "let down" in the second stage of tempering.

The black scale is polished from one surface and a *small* flame played on the handle side of the joint. In this way the heat travels very slowly towards the tips of the jaws and as it does so a sheen will be seen to follow it along the polished surface, First a straw colour will appear, then brown, purple, and finally a brilliant blue. When this blue colour has reached the tips of the jaws, they should again be quenched immediately in either water or oil.

The pliers are now ready for a final polish, or if intended for use in the surgery, they can be chromium plated.

NOTE

We acknowledge with thanks permission to reproduce figures 1, 4, 5 *and* 6 *from the British Dental Journal.*

Twins

By B. R. Townend, F.D.S., R.C.S., L.D.S.

It was demonstrated that in monozygotic twins there was a very high degree of similarity in the shape and size of the teeth and in the pattern of their arrangement. Very insignificant anomalies such as peculiarities of cusp formation, slight rotations etc. were often present in the mouths of both twins. In cases of grosser irregularities the general pattern of malocclusion was usually the same but it was sometimes more severe in one twin than the other. Marked differences in occlusal pattern were produced when one twin had a bad sucking or swallowing habit and the other had not.

In dizygotic twins, tooth shape and arrangement varied considerably. The mouths of dizygotic twins could be very similar in the same way that the mouths of siblings of different ages could be similar, or *vice versa*. Examples were shown of mouths exhibiting a considerable degree of similarity and others which were very dissimilar.

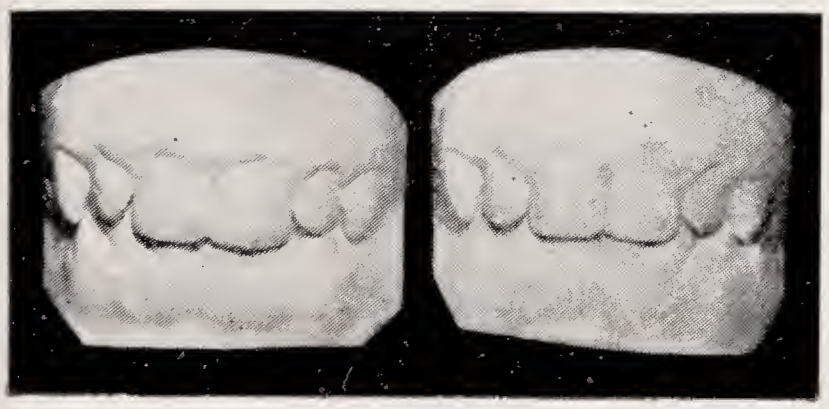


FIGURE 1

Monozygotic twins showing very similar tooth shape and arrangement.

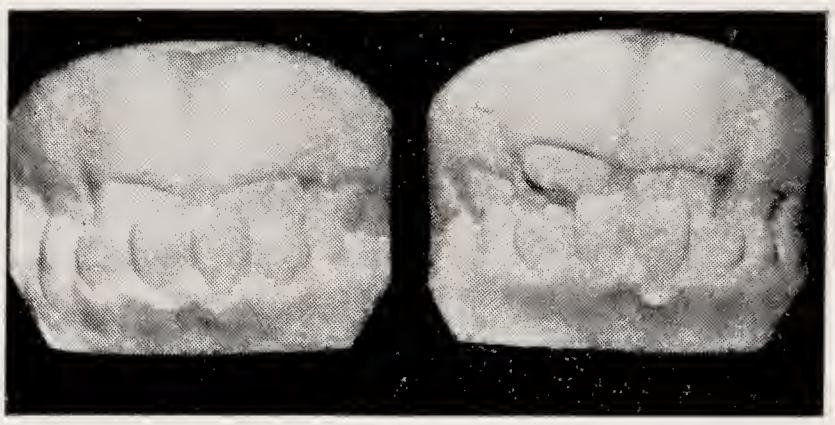


FIGURE 2

Monozygotic twins showing very similar malocclusions.

FIGURE 3

Monozygotic twins, one a thumbsucker and the other normal.

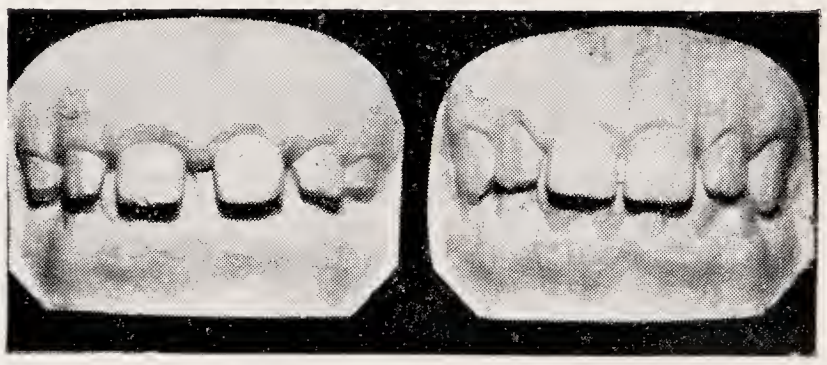


FIGURE 4

Dizygotic twins showing marked variation in tooth arrangement.

FIGURE 5

Dizygotic twins showing marked variation in tooth size.

A demonstration at the meeting held on 8th May.

Extra-Oral Anchorage In Class III Cases

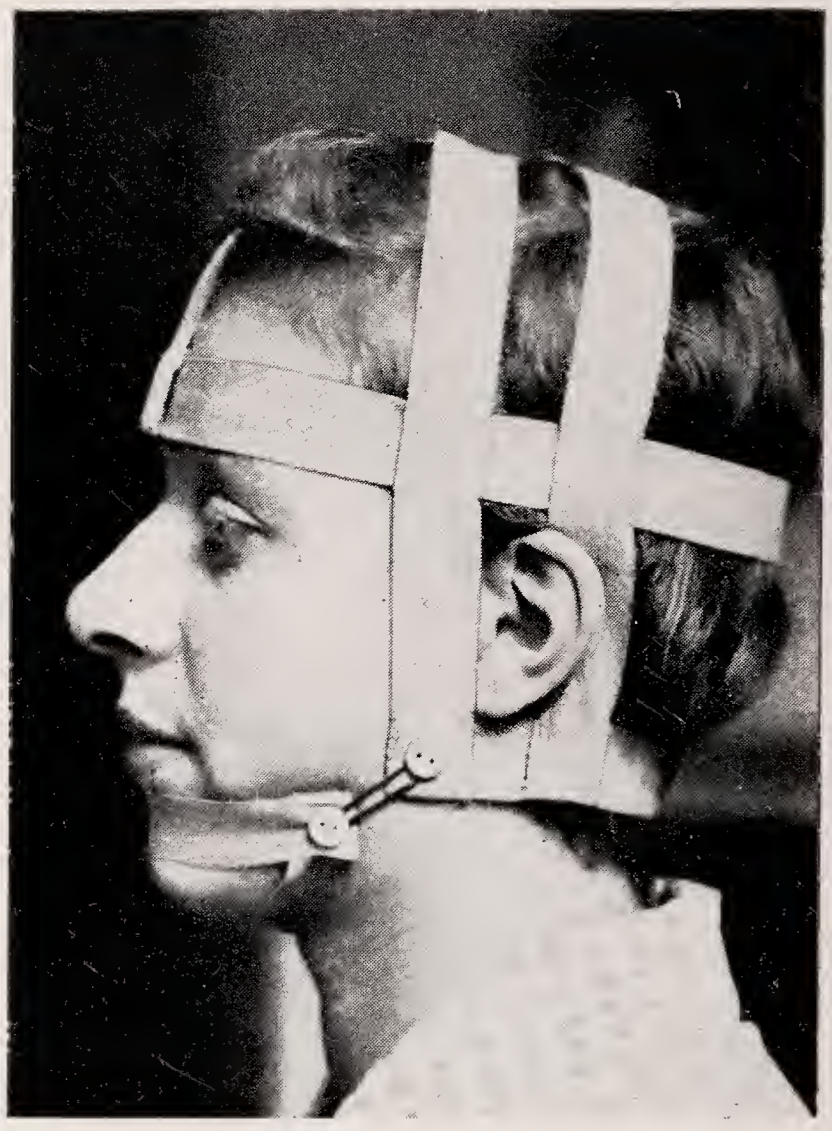
By Harold Chapman, f.d.s.r.c.s.

Five Class iii cases were shown: three were corrected with extra-oral anchorage using head and chin caps (*Fig.* 1) only, except a lower plate to eliminate the overbite. In one, treatment started at age 1-5, in another 2-3 and in the third at 6-4. In these cases the head and chin caps were worn always. In *all* the cases the rubber bands exerted a pull of two ounces.

Two other cases were corrected with fixed appliances and intra-oral intermaxillary traction, a lower plate being used to eliminate the overbite. The intra-oral intermaxillary traction was supplemented by extra-oral intermaxillary supplied by rubber bands connecting the head and chin caps (*Fig.* 1). In one case, treatment was started at age 13-2 and continued for four years with the lower appliance removed at the end of two years; the head and chin caps being used after the removal of the upper appliance at age 17-4. Models at age 23-8 showed that no relapse had occurred. The father was Class III, probably his father and mother also were Class III. The co-operation at the beginning of treatment was not good.

In the second of these cases (*Fig.* 2), treatment was begun at age 13-11; all first permanent molars had been removed on account of caries. Treatment was with fixed appliances and intermaxillary traction

(B)



(A)

FIGURE 2

A demonstration at the meeting on 8th May.

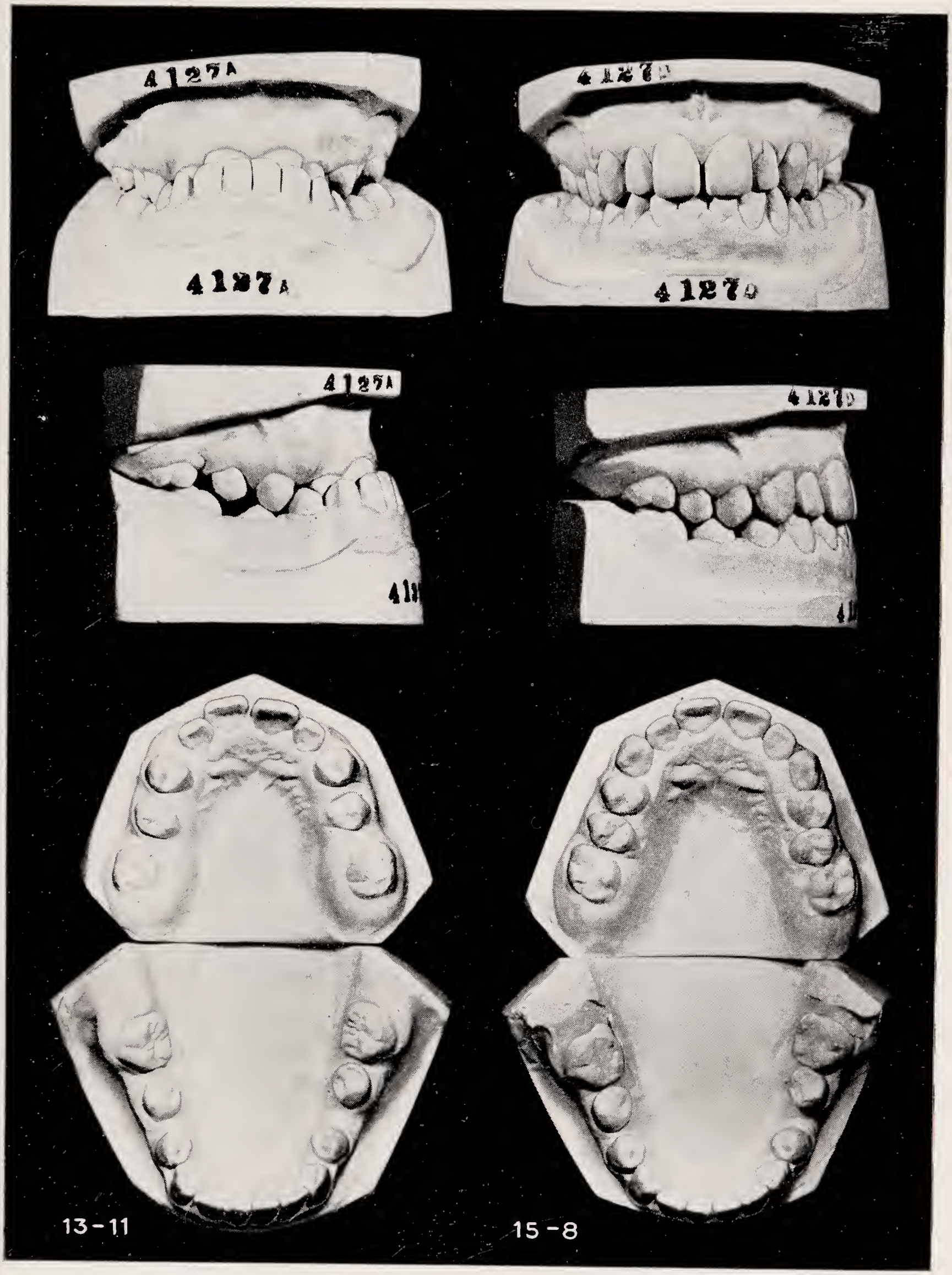


FIGURE 1

which was supplemented by extraoral anchorage, using head and chin caps; as in the previous case these were not worn always, but the co-operation was excellent throughout. The pre-normal occlusion was corrected at 14-8 when all lower appliances were discarded. Treatment is being continued to move the upper premolars distally to make room for the canines; this has been accomplished on one side and has since been completed on the other at age 15-8.

An additional case was shown in which the dentition was 6 43C21 | 12C34 6 all in excellent alignment, 6 4 and 4 6 were in contact, 5 5 were unerupted between 6 4 4 6. Fixed appliances and intermaxillary traction as used for Class III, were used to move 6 | 6 disatlly, followed by a lower lingual arch to move 43 | 34 medially, C C having been extracted. 5 | 5 are now erupted in position between 6 4 | | 4 6. There was medial drift of 6 | 6 which are being moved distally with a lingual arch and auxiliary springs as in the previous case.

A METHOD FOR TEACHING

The Fundamentals of Wire Bending Technique

C. P. Adams. b.d.s.

"The aim (of dental education) should be to turn out general craftsmen with first-rate standards rather than men long practised in particular processes . . . Technical training in dental schools in this country has followed too long the old apprenticeship methods . . . what is required is not years of repetition on the part of the student, but a study of instructional method on the part of teachers. The distinction between designing and making appliances has been insufficiently recognised in the teaching of dentistry. Dental appliances whether orthodontic or prosthetic tend to be mere copies of others that have been used in vaguely similar circumstances[1]".

It was these words that originally inspired a technique system which was evolved in an attempt to divide appliance construction into technical procedures and appliance design. The fundamentals of appliance design have already been fully treated by another author[2],[3] and do not enter into the present article. Technique is here considered as a quite isolated entity. A series of exercises has been devised on which a beginner can practise for a time before attempting appliance construction. The most important point about the exercises is that they can be most easily and quickly done if certain methods of wire handling are used. These methods when understood apply to all points in appliance construction. The exercises also give the student an ever ready opportunity to practise technique and it is quite easy for him to assess his standard of work and his rate of improvement because the geo-

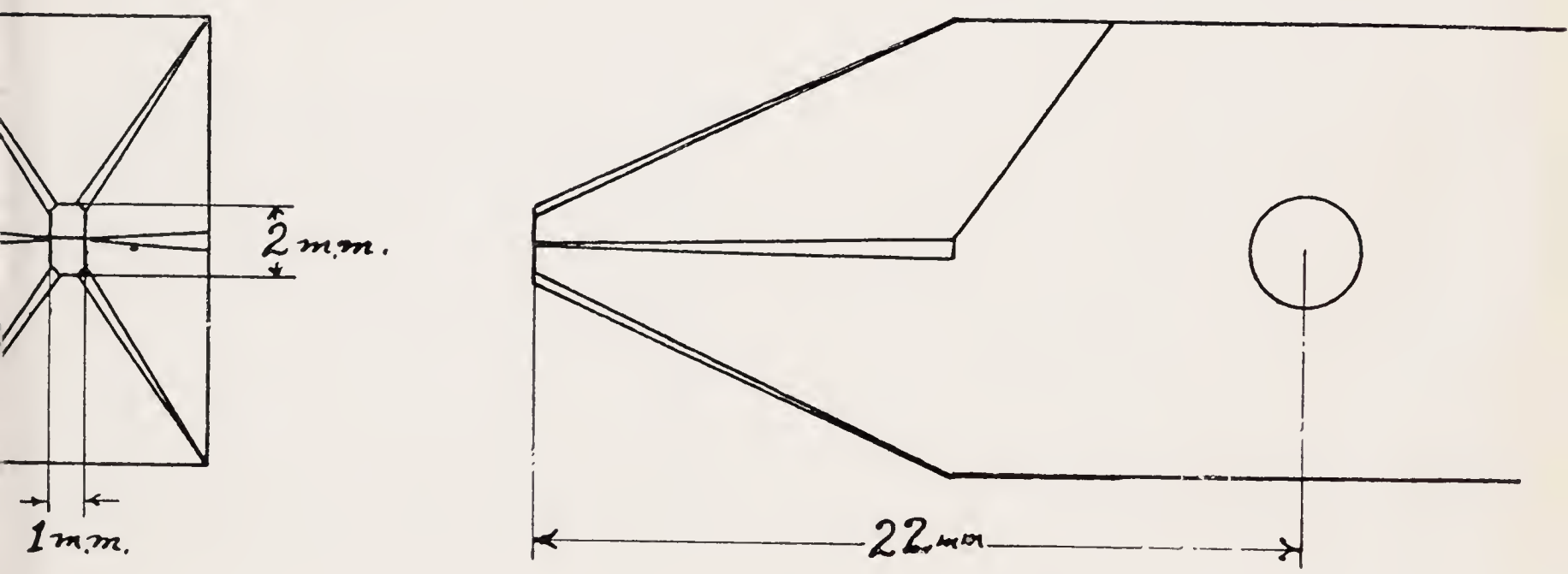


FIGURE 1. Universal Pliers.

A demonstration at the meeting held on 8th May.

metrical form of the exercises makes it impossible to be in doubt as to whether the wire is correctly or incorrectly shaped.

The whole system is based on the use of a single pair of pliers called, for this reason, Universal Pliers. The first essential feature of these pliers is that they are strong and short-nosed so that they will take a powerful grip of the wire with a reasonable hand pressure. The remaining features are detailed in *Fig.* 1. The outer corners of the blades are slightly chamfered but not rounded, the edges of the grasping surfaces are left sharp, there must be no roughening or grooving of the inside of the blades. When the blades are closed there should be a slight gap at the hinge end, tapering to contact at the tips. This is arranged so that when the pliers grip at 1 mm. wire, the inside surfaces of the blades are parallel. This prevents any tendency of the wire to shoot out when grasped firmly with the tips of the blades.

All the exercises are performed on 1.0 mm. wire. The exercises demonstrate the following points in technique.

Fig. 2—Placing sharp turns at precise points.

Fig. 3—Fitting wire into corners.

Fig. 4—Fitting wire round smooth curves and into corners.

Fig. 5—Lingual arch prototype, touching all the pins.

Fig. 6—Lingual arch prototype, fitted to molars.

Fig. 7—A three-dimensional exercise of the lingual arch type.

All these wires when formed and fitted must be *perfectly passive* and must *fall off* when the block is inverted and gently shaken. At the same time they must not be so loose that they rattle when the block is shaken, the wire must also lie quite flat on the block.

The principles and methods of wire forming are few and simple.

1. An adequate length of wire should be used so that a long end is available for manipulation while the formed

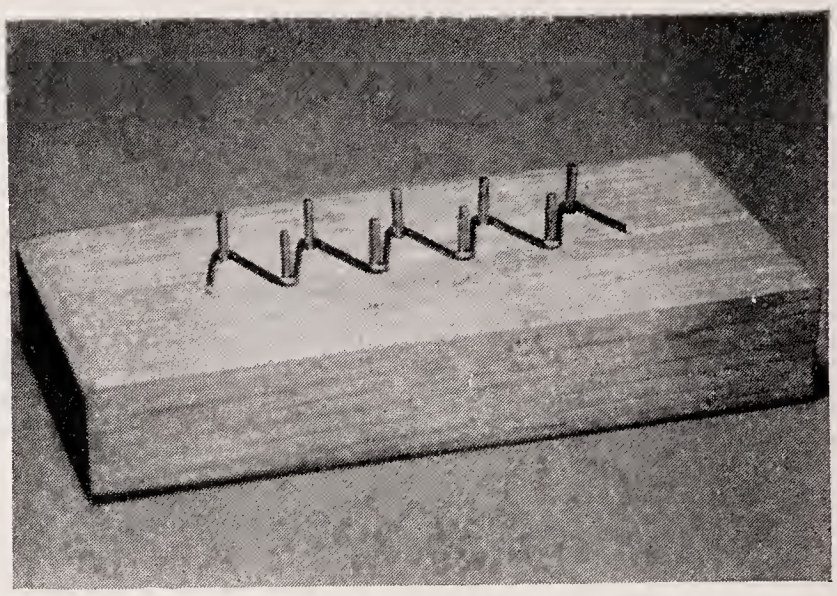


FIGURE 2.

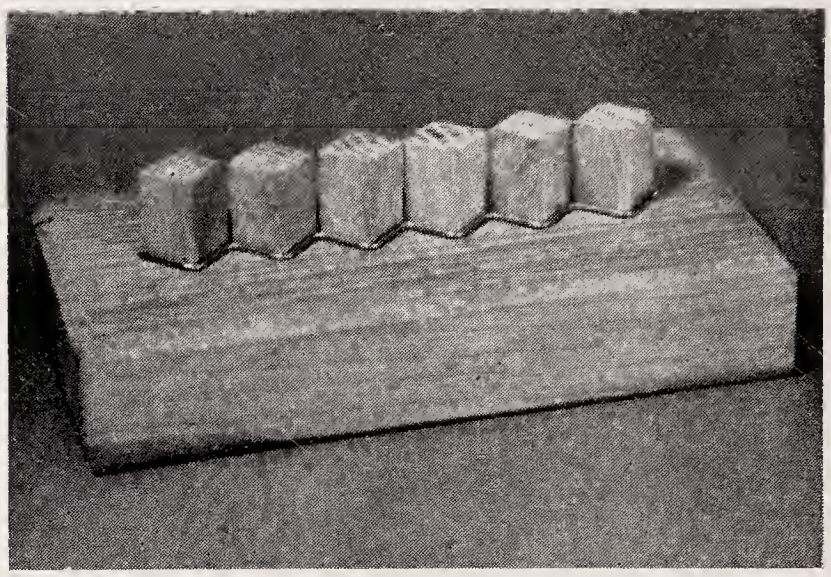


FIGURE 3.

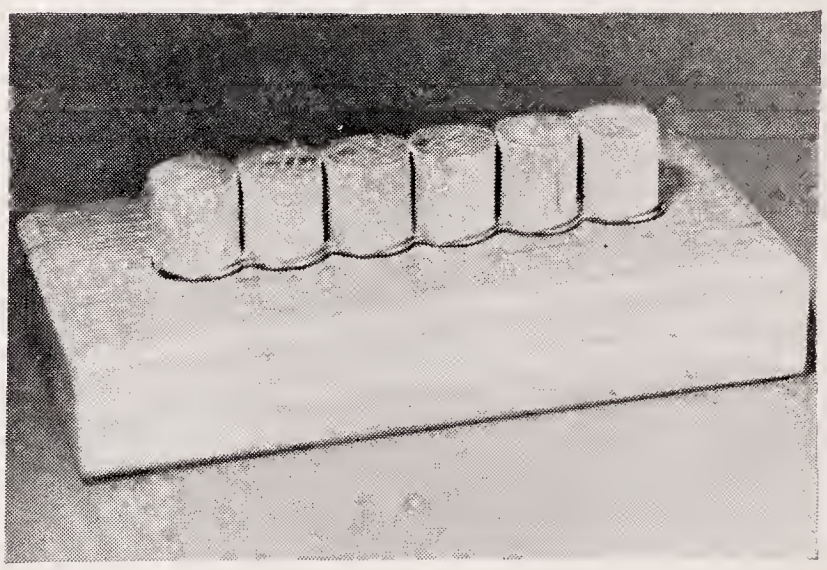


FIGURE 4.

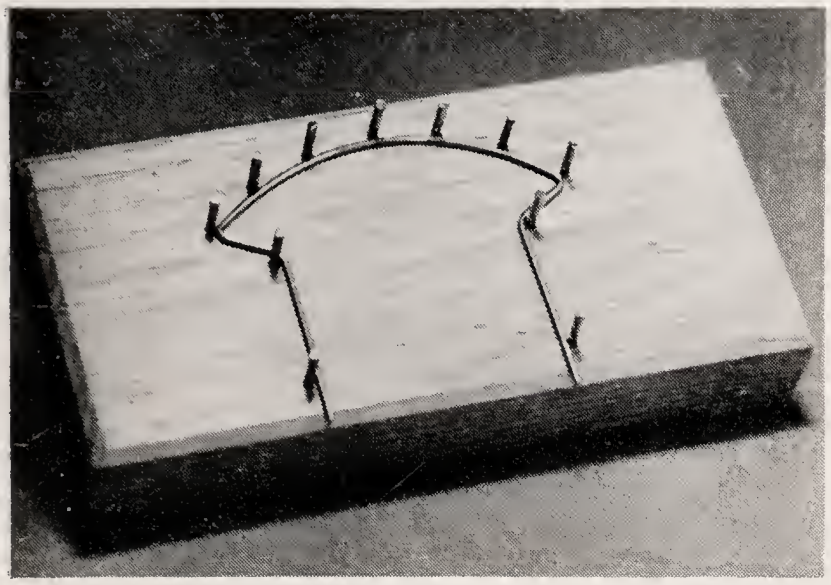


FIGURE 5.

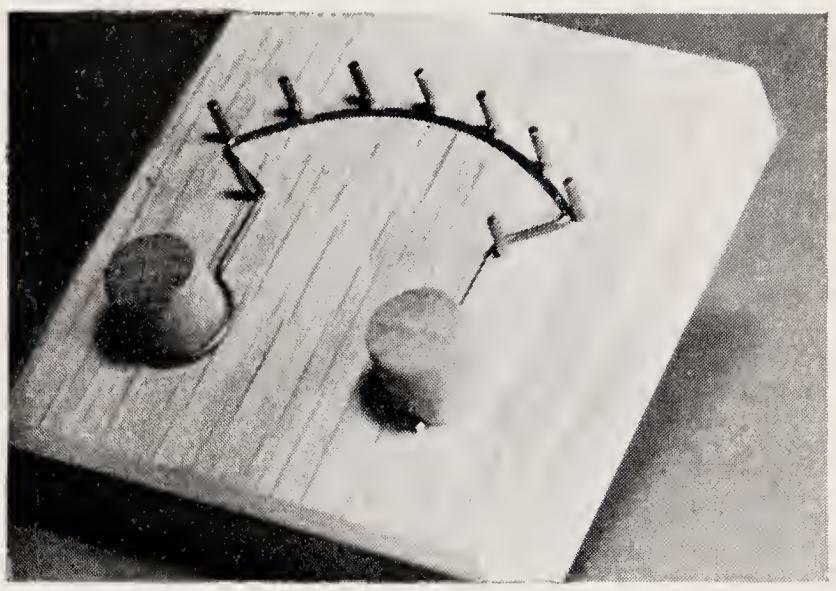


FIGURE 6.

part of the wire is held in the pliers and so away from any possibility of accidental distortion.

2. The pliers should be used to hold the wire firmly and still while it is bent using the free end of wire. It is a bad principle to hold the wire still and bend it with the pliers. *Figs.* 8, 9 illustrate this point.
3. It should always be arranged that the free end of wire is held in the hand in such a way that the thumb is used to bring pressure on the wire, the other fingers being wrapped round the wire.

Sharp bends are made by bending the wire over the corner of the end of the plier blade, not round the end of the blade. *Figs.* 8, 9. Smooth bends are made from a large number of small bends. If the wire has been sharply bent at a slightly incorrect position, a correction may be made if the wire is straightened as indicated in *Fig.* 10. A portion of the bend is gripped in the tips of the plier beaks and squeezed. This has the effect of straightening the small section of wire selected without interfering with the remainder of the bend which may, in fact, be just as it was intended to be. This method of correcting bends is better than straightening the whole bend and starting again as this is liable to over-stress the wire and render it crystalline and very liable to break under the forces it later encounters in the mouth.

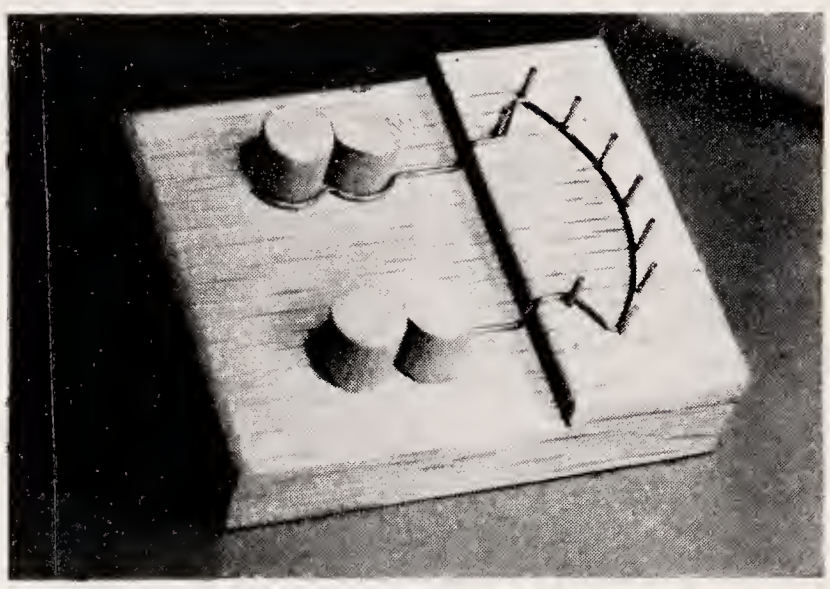


FIGURE 7.

Fig. 11 illustrates how wire is worked into corners. The principle here is that the bend that fits in the corner is prefabricated as it were and then worked down into place in the corner. This kind of bend is often required when constructing lingual arches and it is required to fit some part into the interdental spaces.

When carrying out these exercises, the fit of the wire should be checked at every stage and mistakes corrected as they arise and inaccuracies not allowed to accumulate. This is a most important principle as it is futile to try to correct a discrepancy due to a recent bend by going back beyond this point and interfering with the early

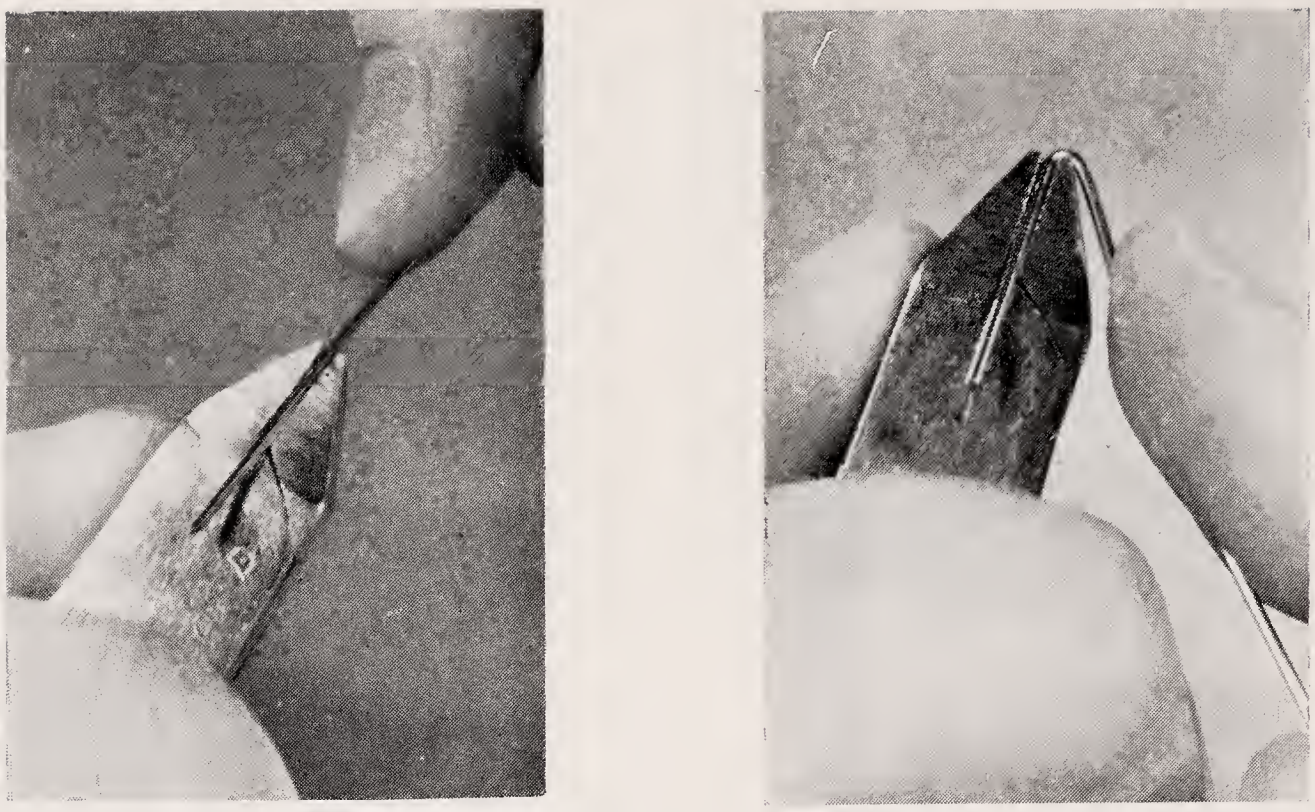


FIGURE 8 a & b

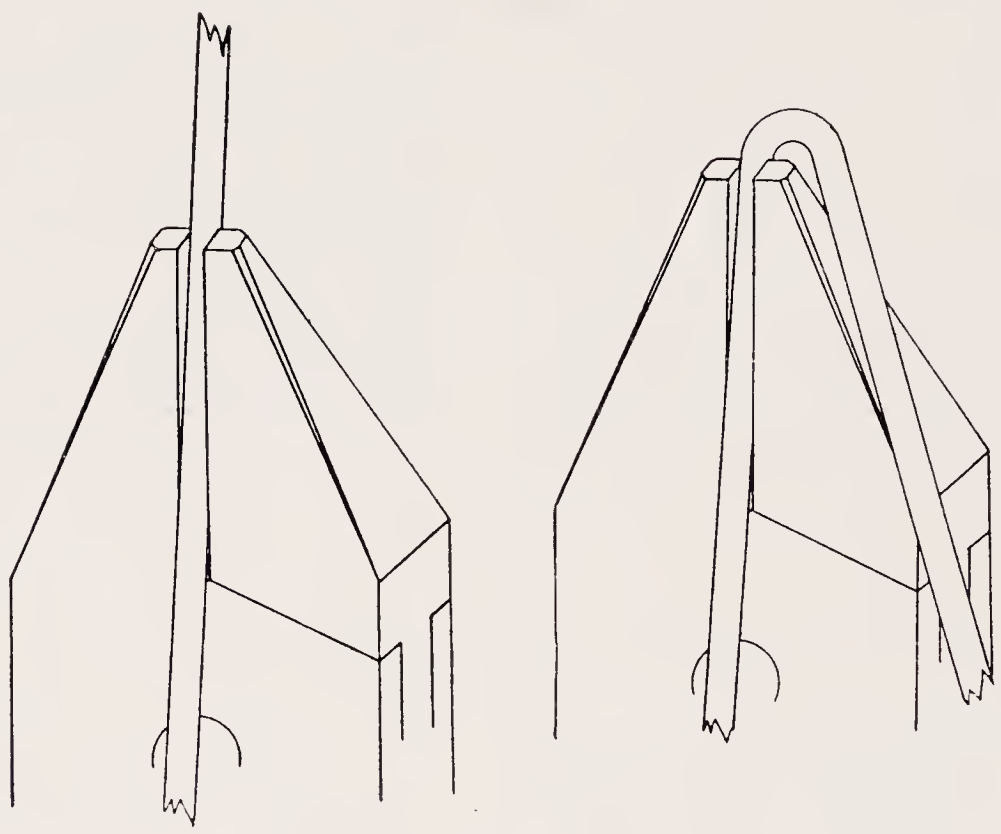
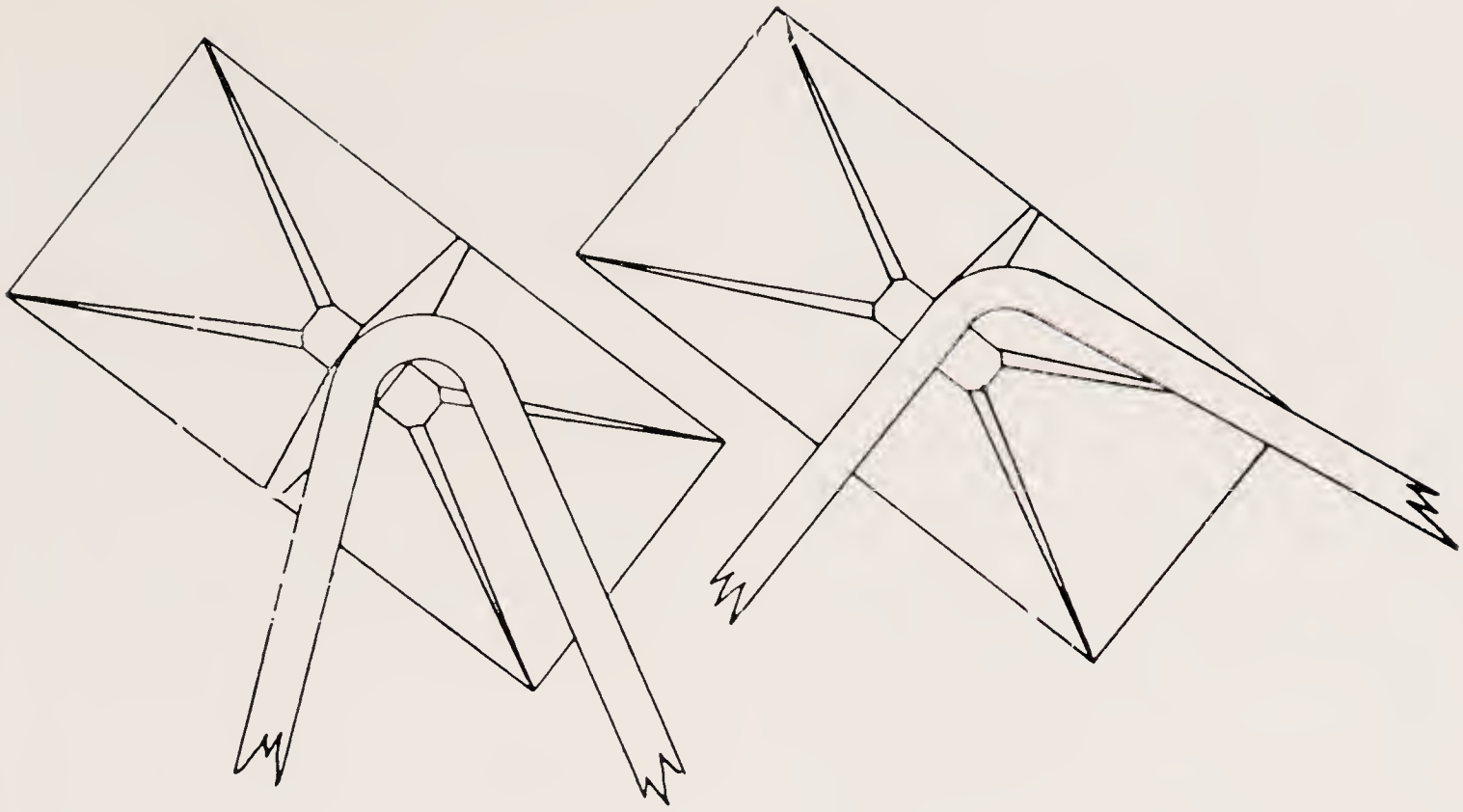


FIGURE 9 a & b

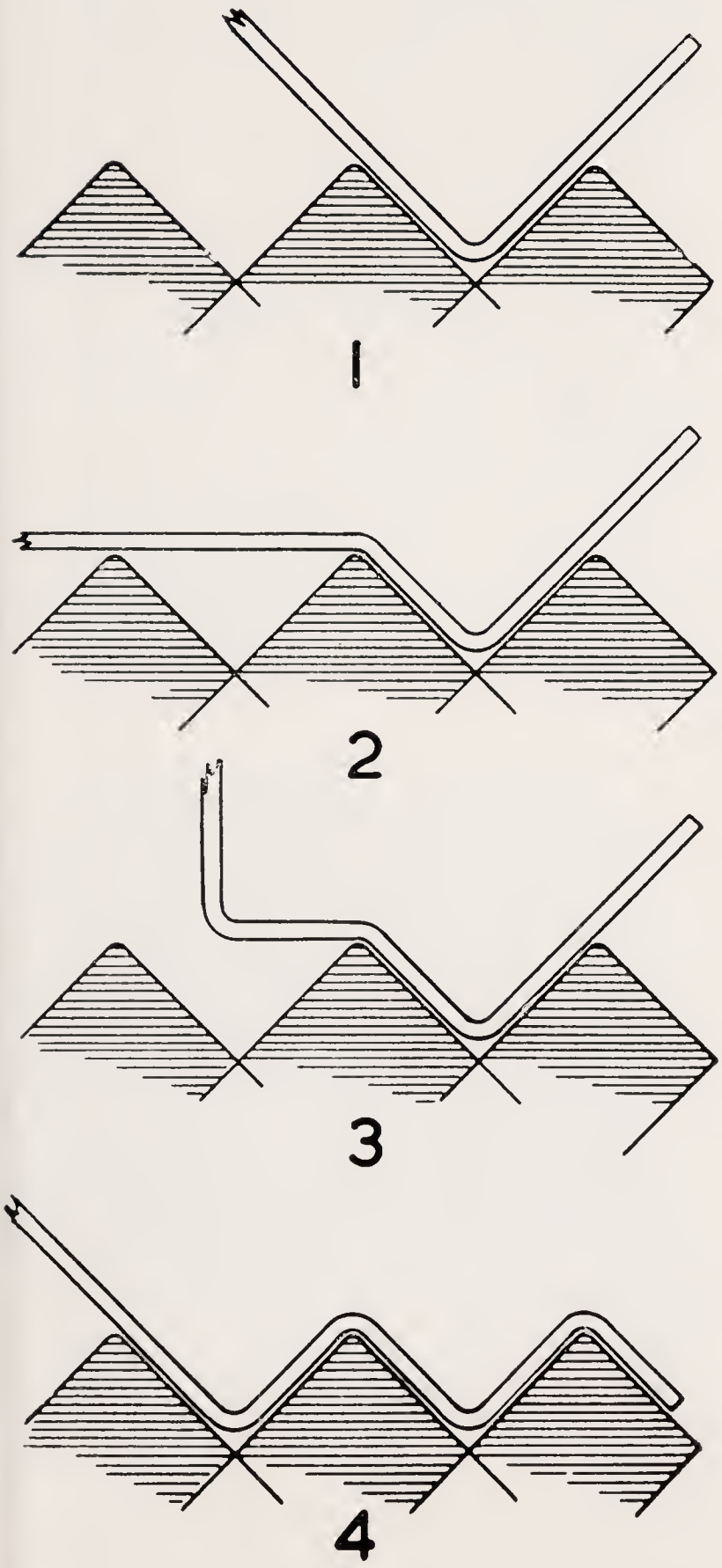
part of the exercise which is presumably correct.

The first three exercises demonstrate all the fundamental principles of wire bending except the operation of making arches. The fourth, fifth and sixth exercises reproduce the conditions met with in constructing lingual or labial bows where, of course, absolute passivity is essential. The construction of auxiliary springs is not dealt with; this naturally requires the use of round nosed spring-forming pliers and their use is easily mastered when the principles of forming stiff wires are understood and practised.

The scheme of technique exercises outlined here is suitable not only for the student who has to learn the fundamentals of wire bending technique from the beginning, but also for the enthusiast who wishes to check his methods and skill and strengthen and speed up his technique.



above FIGURE 10 a & b



left FIGURE 11

This system of technique instruction was originally conceived and put into practice at the School of Dental Surgery, Liverpool. The author wishes to acknowledge the wholehearted support and encouragement that were given to the scheme by Professor H. H. Stones, Mr. J. W. Softley and the members of the teaching staff of the Orthodontic Department, and to thank Mr. F. D. Rowe for making the photographs for *Figs.* 2—7 inclusive.

REFERENCES

McKeag, H. T. A. "Education for Dentistry." *Brit. Dent. Jour.* Sept. 3, 1943.

McKeag, H. T. A. "The Teaching of Appliance Design in Orthodontics." *Dental Record,* 56, 260-282, 1936, and *Trans. B.S.S.O.* 1935

McKeag, H. T. A. "Design and Construction of Fixed Orthodontic Appliances in Stainless Steel." *Trans. Europ. Orth. Soc.* 1938.

THE PROGRESSOR *

H. E. WILSON, L.D.S.

THIS APPLIANCE WAS first demonstrated by Prof. Hotz of Zurich at the European Orthodontic Society's meeting, 1949. It's use is limited to Class II, div. 1 cases where there is loss of space in the lower arch, due to early extraction of lower deciduous molars, and lingual tilting of lower incisors and canines. It obviates the necessity for an appliance to make room for the lower premolars before the correction of the distal relationship.

It is activated in the same manner as the Andresen appliance, that is, by the muscles of mastication and deglutition. For this reason it requires a bite with the mandible brought forward into a normal mesio-distal relationship, or if the patient can tolerate it, a more forward bite than that required for the Andresen (*Fig.* 4). In taking the bite it is essential to open it at least 2 mm. in the incisor region, that is, there must be at least 2 mm. between the upper and lower incisors vertically. This is important for it allows the lingual movement of the upper and labial movement of the lower incisors (*Fig.* 5).

The models are mounted on a block articulator in their new relationship. A sheet of toughened wax is softened and moulded round the labial and buccal aspects of the upper from the first molar on one side to the first molar on the other. It is trimmed along the gingival margins of the posterior teeth and the incisal edges of the anterior teeth, canine to canine. A second sheet of wax is moulded to the lingual side of the lower from first permanent molar to first permanent molar and again is continued as high as the incisal edges of the lower anterior teeth. Where spaces exist in the lower premolar region it is continued over and on to the buccal side of the alveolus. These two *base plates* are joined together by a roll of wax between the upper and lower anterior teeth, canine to canine. It is then processed in acrylic, preferably clear acrylic.

When fitting the appliance care should be taken that free lingual movement of the upper incisors and labial movement of the lower incisors is possible and the appliance trimmed if necessary. It is sometimes necessary to trim it away from teeth requiring less movement than others in the same arch.

The Progressor is worn at night and for a practice period during the day. It seems to be more easily tolerated than the Andresen appliance.

At subsequent visits additions are made on the upper and lower incisal areas with cold curing acrylic. Occasionally additions have to be made to areas such as the distal aspect of the first premolar or the mesial aspect of the first permanent molar of the mandible. The success of the treatment by this appliance depends on these additions being made. It is necessary, therefore, to see the patient more often than would be necessary with an Andresen appliance.

The Progressor is not intended for treatment of unmutilated Angles's Class II, div. 1, cases and is in fact contra-indicated for such cases. In conclusion, therefore, I should emphasise that it is used only in Angle's Class II, div. 1 cases, aggravated by the collapse of the anterior part of the lower arch due to early extraction of the deciduous molars.

FIGURE 1

The "Progressor," side view.

**I have learnt, since giving the demonstration, that the name originally suggested for the appliance was the "Protruser."*

A demonstration at the meeting held on 8th May.

Fig. 2
The " Progressor," front view.

Fig. 4
The models mounted on a block articulator in the advanced position.

Fig. 6
The " Progressor," in position.

Fig. 3
The models in their natural occlusion.

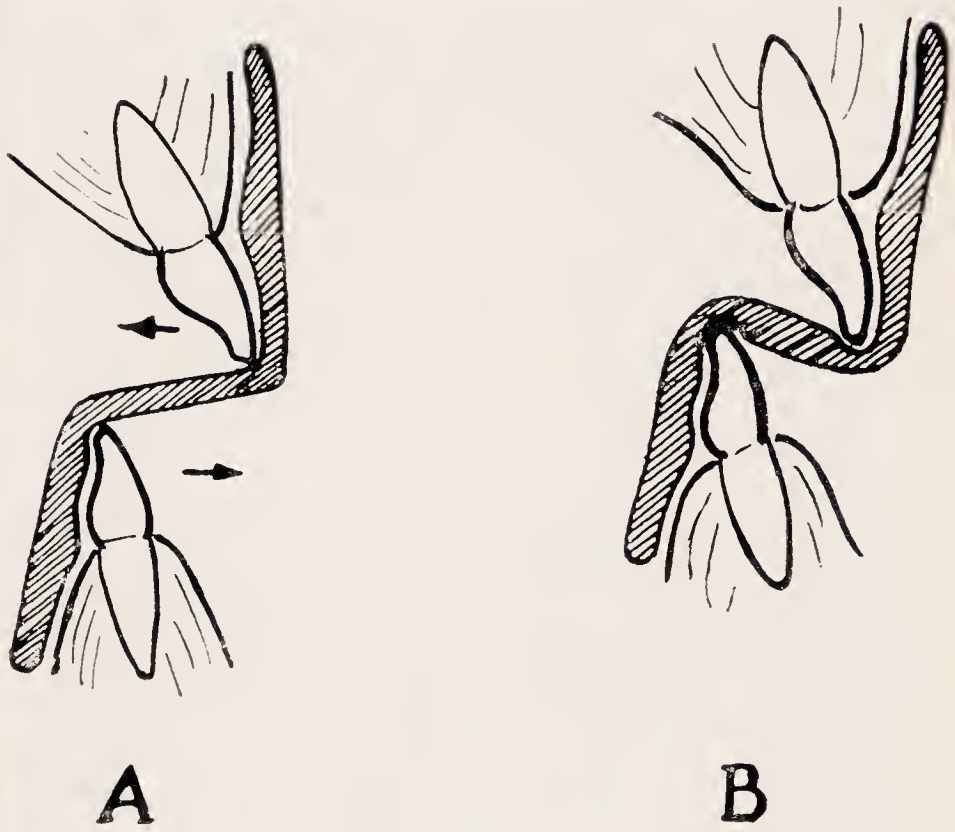


Fig. 5
A. illustrates the correct vertical opening of the bite in the incisor region. This allows the teeth to move in the desired direction with the addition of acrylic, labially to the upper and lingually to the lower teeth.
B. shows a too close bite with that part of the appliance between the upper and lower incisors preventing the movement of these teeth in the desired direction.

Late Orthodontic Treatment in a Case of Cleft Palate

W. J. Tulley, B.D.S., F.D.S., R.C.S.

In this short communication I wish to report the late treatment of malocclusion in a case of repaired cleft palate and hare lip.

The patient, a woman aged 23, presented with the following history. A unilateral harelip, cleft alveolus, hard and soft palates had been repaired by a series of operations before the age of three years. The functional result with regard to speech and swallowing was perfect with no nasal escape. There was, however, the inevitable contraction of the maxillary dental arch and rotation of the upper left central incisor with a supernumerary in the line of cleft. The upper left lateral incisor was missing and the bite was locked due to extreme linguo occlusion of the upper left buccal segment. (*Fig.* 1.)

The treatment was based on the possibility of moving the teeth and the alveolus

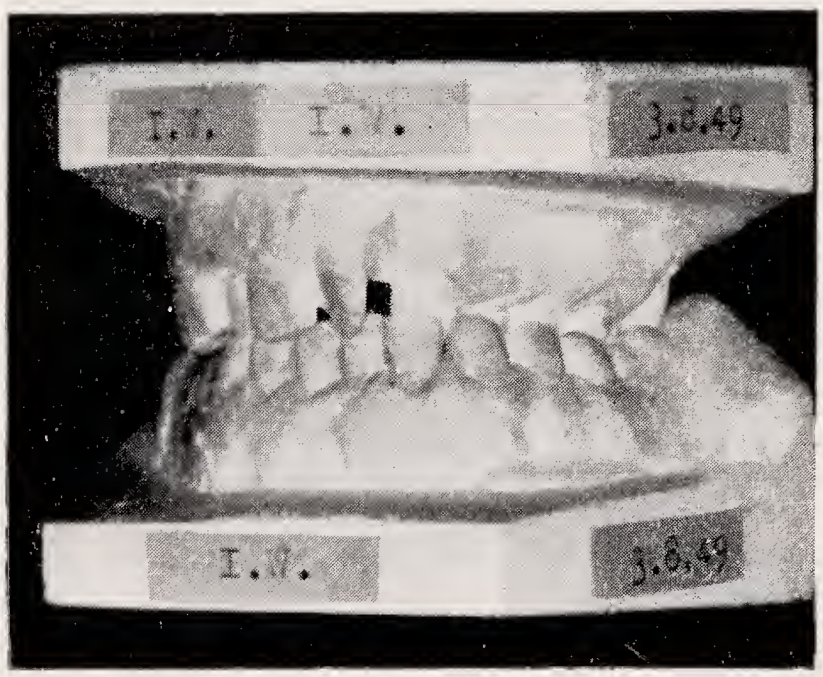


FIGURE 1.

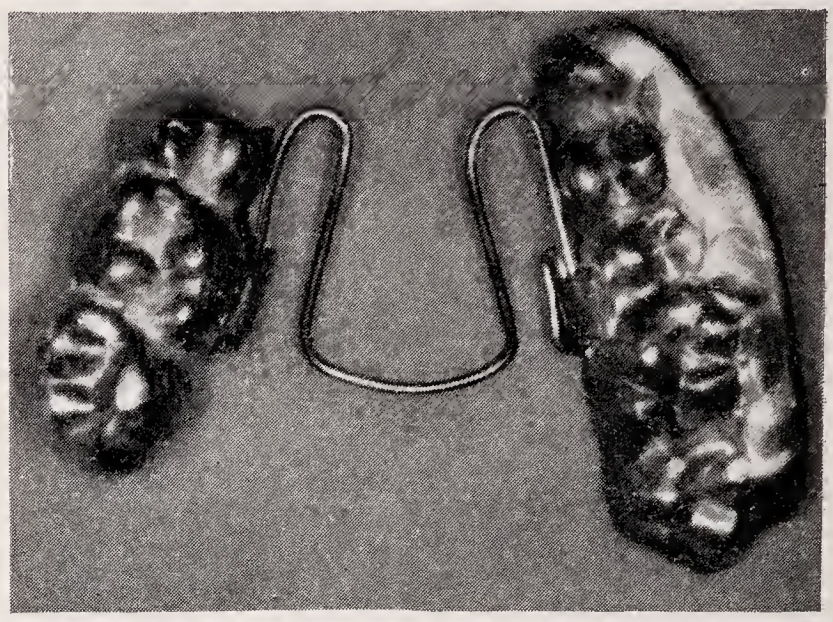


FIGURE 2.

bodily, stretching the tissues in the line of cleft as Harvold has reported, and no orthodontic treatment was attempted in the incisor region.

The supernumary was extracted and the appliance inserted. This consisted of cap splints cemented on to the buccal segments connected by a palatal bow in .9 m.m. wire. (*Fig.* 2). This bow was locked into the splints on each side so that it could be easily removed for adjustment.

Tension was gradually increased by opening up the bow and no discomfort was felt by the patient. Active treatment extended over a period of five months.

After the removal of the appliance a small palatal plate was used for night retention. To improve the incisor region and to lock the buccal segment the patient was referred for conservative treatment. The upper left central was devitalized and post-crowned and a fixed bridge in-

Short Communication presented to the meeting on 9th October.

serted between the central and the canine carrying a small pontic.

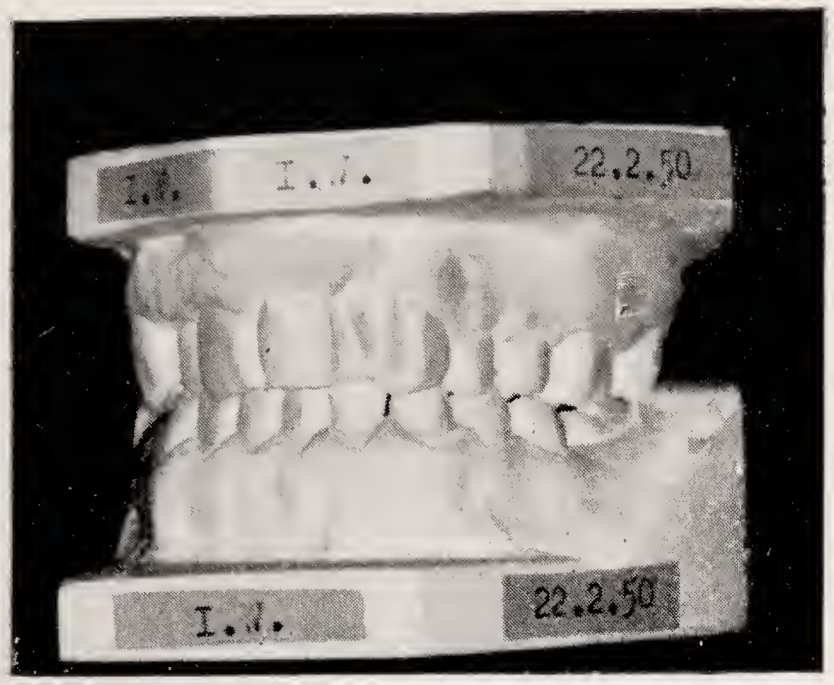


FIGURE 3

Not being used to making lateral excursions of the mandible during mastication, the patient felt some discomfort in the temporo-mandibular joints but a little grinding of the bite to remove cuspal interference enabled her to chew perfectly and the joint pain disappeared. (*Fig.* 3).

In conclusion, it seems fairly certain that apart from some movement of the teeth in the alveolus the arch was actually expanded. (*Figs.* 4 & 5). Despite the median cleft, the maxillary segment on the left side had firm attachments to the frontal zygomatic and sphenoid bones.

Harvold explains the expansion, by remodelling of bone in the suture region between the maxilla and the neighbouring bones as shown by incorporating dyes in the diet of monkeys during treatment of artificial clefts. I have merely presented this case out of clinical interest and do not wish to make any comment on possible bony changes which must have occurred

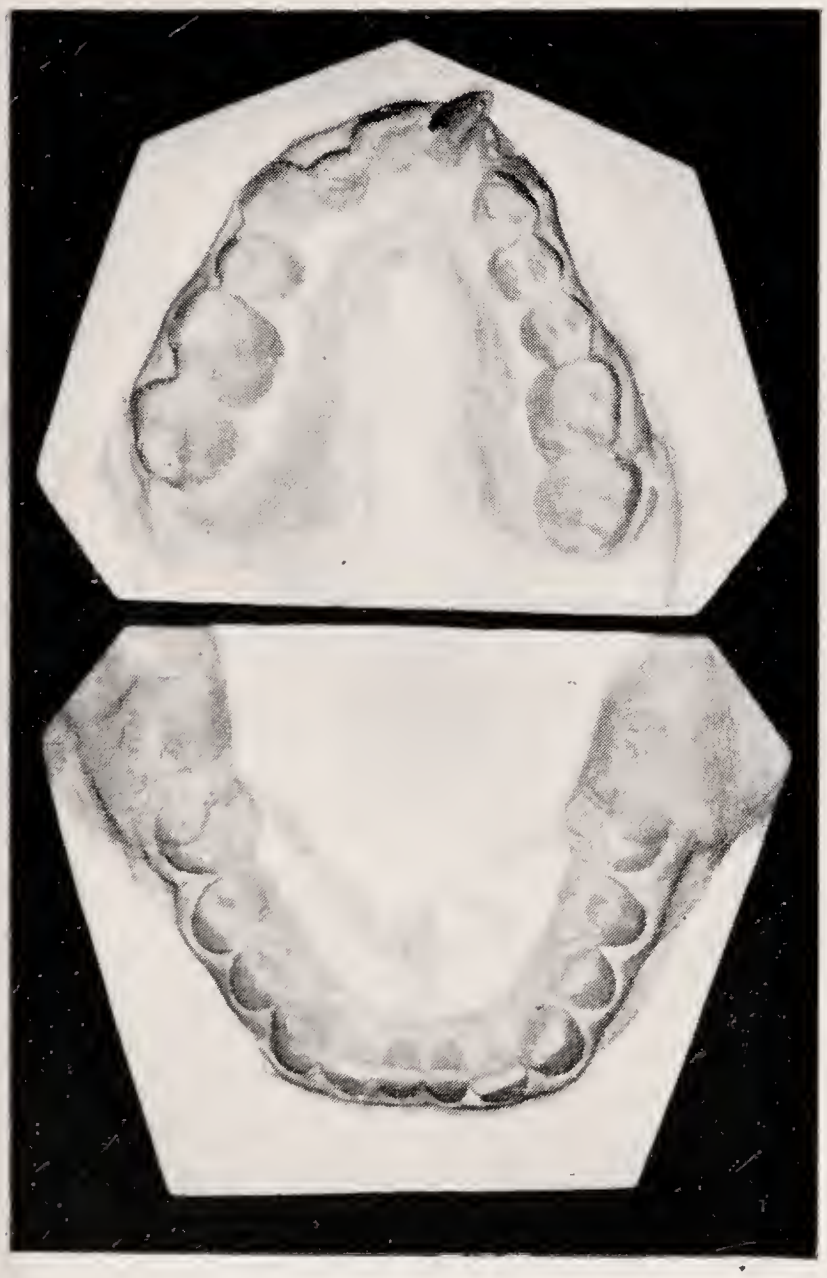


FIGURE 4.

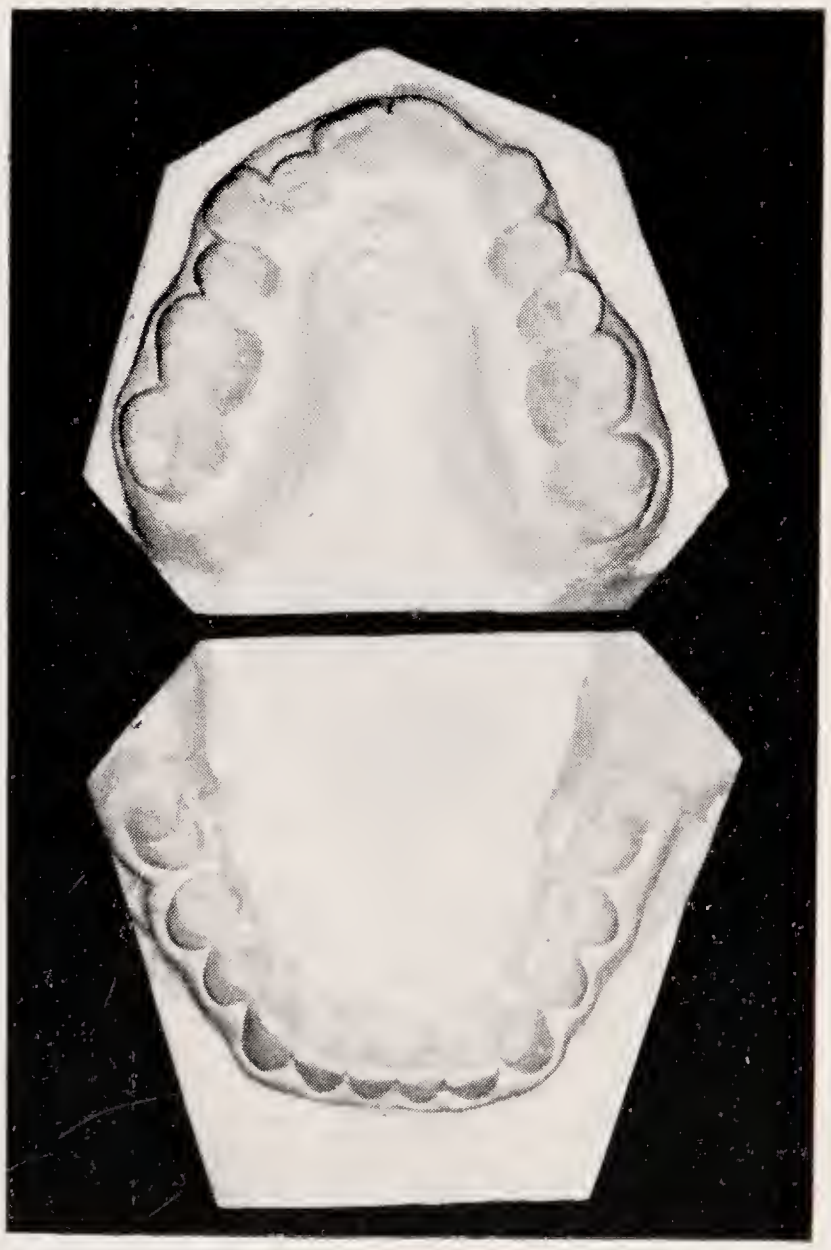


FIGURE 5.

despite the relatively late treatment.

I would like to thank Mr. Rix for permission to present this case which was under his care at Guy's and Mrs. Small of the Dental Photographic Department for preparation of the slides.

REFERENCES

Harvold, E. *Cleft Palate, an experiment. Den Noeske. Tannlaegeforenings.* Mars 1949. *Tidewde Hefte* III.

Harvold, E. Observations on the development of the upper jaw; harelip and cleft palate. *Odontologisk Tidskrift* (1947) **3,** 289.

DISCUSSION

The President said he felt sure the Society would have found this Communication as interesting as he had done. He did not suppose Mr. Tulley could be expected to clear up that somewhat mysterious transaction which occurred in the cleft when separation of the segments was undertaken. He confessed to some doubts as to whether the explanation given currently was a genuine one, but it was evident that Mr. Tulley had not gone into that.

Studies on the Growth and Form of the Mandible [1]

N. B. B. Symons, B.D.S.,* M.SC.

The mandible, it is generally agreed, is the most " plastic " bone of the human skeleton. It is implied in this, what is well known of it, that it alters its form more during development, that its final functional form varies more from person to person, and that it is required to respond by structural change to changes in the parts related to it more than any other bone of the body. This " fluidity of form " must be due, I have thought, to its want of organic relationship with the other skull bones, for its skeletal relationship with them is only at the temporo-mandibular joints and through the spheno-mandibular ligaments. The only directly "skull-determined" feature of its form is, therefore, its bicondylar width which must agree with the temporal breadth of the skull. The other main feature of its form, namely its length from the articular condyle to the chin, need agree only in a general way with the length of the base of the skull and upper jaw, for the relationship to be established through its length is not of itself but is the proper occlusional contact of the teeth it carries with the teeth of the upper jaw. The mandibular teeth, it will be held, are carried not on the mandible proper itself but on a process of it, the alveolar process, a tooth bearing bone, which may differ in size and form from the mandible proper, which grows independently of and differently from it, and which may be modified by structural change without a corresponding change in it. The occlusional contact of the teeth is determined therefore, apart from the form and arrangement of the teeth themselves, by the size and form of the independent alveolar bone; and it is effected, it is to be noted, by the muscles which connect the mandible itself, not the alveolar process, to the skull and act at the temporo-mandibular joints. The other muscles which are attached to the mandible, and again to the mandible proper, are those of the tongue, the cheeks, and the floor of the mouth, and they are concerned in the functions of suckling, trituration, swallowing, and speech.

The elements of the mandible and their general form and arrangement are, therefore, in this analysis as follows:—

(1) The mandible proper I consider to be a parabolic curved arch which in front lies more or less parallel to the plane of

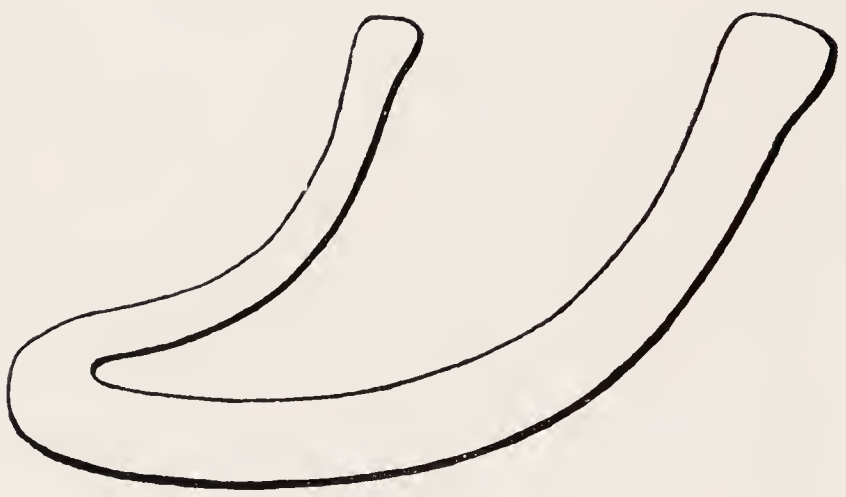


FIGURE 1

the palate but behind ends in turned up parts which terminate in the articular condyles (*Fig.* 1.). This is formed of

[1] *Much of this work was carried out in the Department of Anatomy, The Queen's University, Belfast, during the tenure of a Nuffield Dental Fellowship.*

Paper presented to the meeting on 9th October.

**from the Dental School, University of St. Andrews, Dundee*

lateral halves which meet one another in front at the chin; in the human subject the halves are fused together there as a rule by the end of the first year and growth in length at the front ends of the halves themselves can then no longer occur.

(2) The front horizontal part of the arch has attached to it the muscles of the cheeks, the tongue, and the floor of the mouth, all of them making definite impressions of the bone and not only producing external marks of attachment but affecting, through their pull, the internal structure.

(3) The back parts of the arch carry the insertions of the muscles of mastication in three groups:

(a) the lateral pterygoid is attached directly just below the articular condyle;
(b) the temporalis muscle is attached to an apophysis which projects upwards above the arch;
(c) the masseter and medial pterygoid are attached to an apophysis which projects downwards below the arch.

(4) The anterior horizontal part of the arch carries on its upper rim the tooth-bearing alveolar bone (*Fig.* 2).

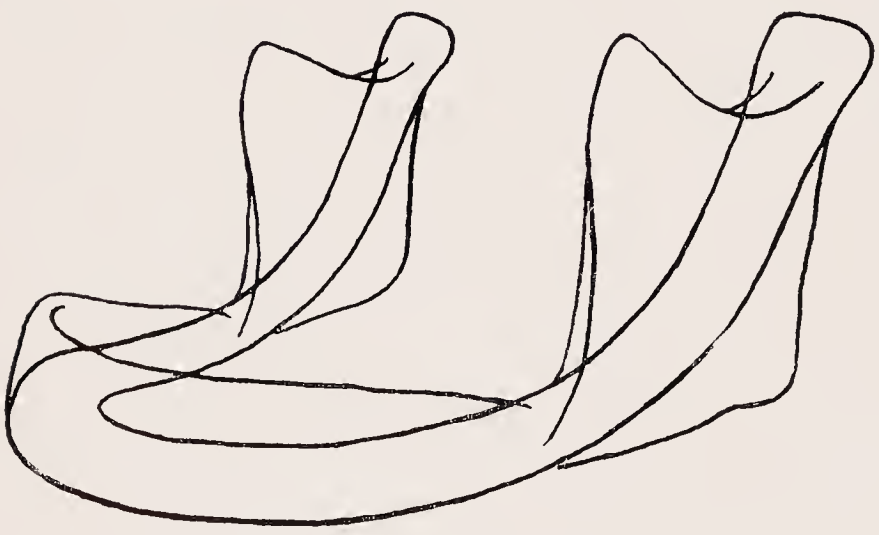


FIGURE 2

In general it may be said that previous separation of the mandible into different parts has been limited to a distinction between alveolar bone and basal bone; the basal bone being confined to the body of the mandible and being that part on which the alveolar bone rests. A distinction of a basal mandibular element was made by Bluntschli and Winkler (1927) which was not confined to the body of the mandible but was continued upwards and backwards through the ramus to the condyle.

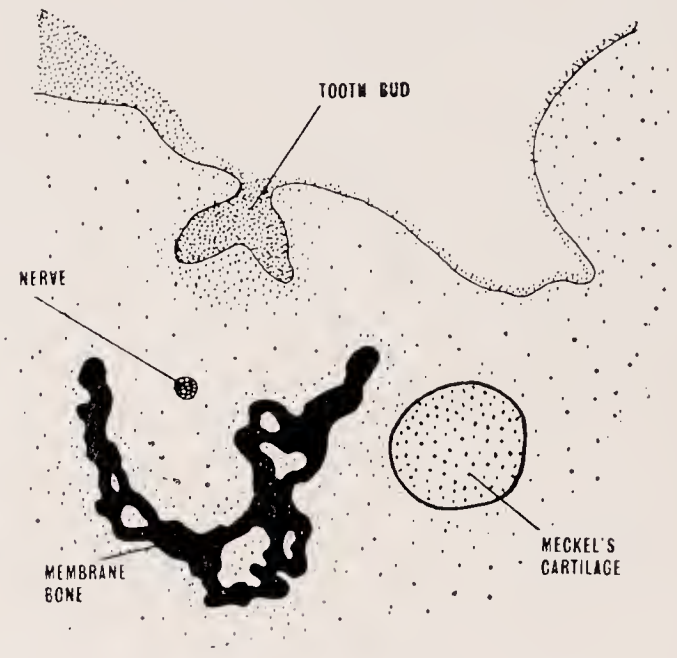


FIGURE 3.

Diagram of coronal section through developing lower jaw showing relationship of tooth bud and bone.

This conception, however, rested on a purely mechanical basis as did the suggestion of a fundamental tube of bone in the ramus advanced by Gullberg and Burkitt (1924). In this work the mandible is resolved on developmental and functional grounds into the elements described. It seems, therefore, that this study should begin with the development and growth of the mandible and particularly of its basic element, the mandible proper.

The Development of the Mandible

The development of the bony mandible is from the beginning closely associated with the inferior dental nerve and its branches. Forming first as a plate of bone on the lateral side of the inferior dental and incisive nerves, it soon spreads beneath these nerves and then upwards on their medial side, so that the nerves come to lie in a trough of bone. At this stage the term alveolar plates (though commonly used) is inappropriate for the bone of this part of the mandible, as these plates enclose

FIGURE 4.

Radiographs of human mandibles showing the condylar bone formation—

(*a*) *four and a half months foetal life.*

(*b*) *five months foetal life.*

(*c*) *newly-born.*

the nerves, forming a support for them, and the developing tooth-germs lie far removed (*Fig.* 3). The bone, then, that has already formed may be considered as constituting the primary mandible body and it is only later by an extension of the plates of bone, above the level where they will bridge over the nerves, and on each side of the tooth-germs, that true alveolar bone is constituted.

The Condylar Cartilage in Man

Very soon after the formation of this primary mandible body the secondary cartilage of the condyle appears (about 50 mm.-eleventh week). This grows rapidly and soon forms a large cone-shaped mass occupying the condylar process and reaching well forward into the ramus. Towards the middle of the fourth month of foetal life thiscartilage begins to be replaced by bone. This process proceeds rapidly so that by four and a half months of foetal life the whole of the cartilage has been replaced by bone except for a narrow strip immediately beneath the fibrous covering of the articular surface of the condyle. Through the proliferation and transformation of the cells of this fibrous layer the cartilage is being continually added to from above while at the same time it is replaced from below. In this way there is a continual addition of bone at the condylar end of the mandible.

The bone that has replaced the preceding cone of cartilage can be seen in an X-ray picture of the foetal mandible of four and a half months (*Fig.* 4*a*). The cone of bone so formed already constitutes nearly half the length of the mandible. The anterior end of the conical bone formation reaches to the alveolus for the second deciduous molar. Above the anterior part of the formation is the developing crypt for the first permanent molar. Above and below the formation are the small flanges or apophyses of bone for the elevating muscles, that for the temporal muscle containing the first permanent molar crypt.

In the mandible at birth, the bony formation is of greater length, and the now considerably larger first permanent molar crypt has extended backwards still above it, to occupy about half of the area of the upper muscular flange (*Fig.* 4*c.*) From the beginning the formation is in line with

FIGURE 5.

Radiographs of mandibles of sheep showing the condylar bone formation—

(*b*) *newly-born.*
(*a*) *foetal.*

the inferior dental canal, its upper border being on only a very slightly higher level. This can be seen particularly well in Figure 4b. Thus this bone formed at the condyle is in direct continuity and in line with the primary mandible body which was formed in relation to the nerve trunks.

The importance of the condylar cartilage in the growth of the mandible was first demonstrated by Charles (1925), for though the presence of the cartilage has previously been described by Low (1909) and by Fawcett (1924) its full significance as a growth centre had not been appreciated. The continued rôle of the condylar cartilage in mandibular growth after birth was subsequently described by Rushton (1944). This growth mechanism persists until the end of the second decade or the beginning of the third decade, during which time it continually increases the length of the mandible. It would appear that by far the greater extent of mandibular length from condyle to symphysis must be produced by it, as apart from its long persistence the only means of adding to the length of the mandible after the first year when the symphysis is closed is by surface addition at the anterior end of the jaw. There is little evidence that this is of much importance in producing mandibular length (Rushton, 1948). The bone, then, formed at this condylar growth centre together with the primary mandible body constitute the body proper of the mandible as defined earlier.

The condylar cartilage, it is to be noted, is formed not only in man but occurs constantly throughout the whole class of mammals, where also it plays an important rôle in mandibular growth. In each case a similar bone formation is produced. Some of the variations can be demonstrated in an ungulate and a carnivore.

The Condylar Cartilage in the Sheep

In the mandible of a foetal sheep, the bone formed at the condyle has the form of a slender cylinder of bone, which except for its tapering anterior tip is of almost uniform thickness throughout its length (*Fig.* 5*a*). The cylinder passes from the condyle obliquely through the ramus into the body of the mandible, the tip reaching the posterior wall of the alveolus for the third deciduous molar on a level with the occlusal surfaces of the deciduous molars. Below the anterior

part of the cylinder is the crypt for the first permanent molar, and immediately behind this and just below the lower border of the cylinder is the mandibular foramen.

At birth the bony cylinder does not at first seem to have noticeably increased in length, this is because the enlarging crypt for the first permanent molar, in extending backwards and upwards, has caused the cutting away of nearly the full thickness of the anterior part of the cylinder, so that it is almost invisible in the X-ray (*Fig.* 5*b*).

After birth the bony cylinder at first continues to increase in length in its original direction but subsequently a pronounced change takes place in the addition of bone to the cylinder, so that the recently formed part of it has a more horizontal direction. Thus in an X-ray a definite angle appears between the oldest and newer parts of the formation (*Fig.* 6). Immediately below this angle is the mandibular foramen, which thus keeps its relation, as in the previous stages, to the lower border of the cylinder. In this specimen, from a sheep of about three months, there is the appearance of the developing crypt for the second permanent molar, behind the first permanent molar and immediately below the bony cylinder. That is, it occupies the same relative position to the cylinder as the crypt for the first permanent molar did in the foetal sheep. The anterior older part of the cylinder in front of the mandibular foramen is beginning to fade out. By six months the whole formation has faded out with the exception of the very recently formed bone in front of the condyle.

It is evident that the condylar bone formation in the sheep bears, as in man, a close relationship to the mandibular foramen and to the crypt for the first permanent molar. It should be noted that the crypt for the second permanent molar succeeds that for the first in this relationship.

The Condylar Cartilage in the Dog

In the mandible of a pup at birth, the condylar bone formation again appears as a cylinder, tapering anteriorly but is proportionally broader than in the sheep

FIGURE 6.

Radiograph of the mandible of a sheep of three months showing the condylar bone formation.

and not so distinct. The cylinder runs from the condyle almost horizontally into the body of the mandible, reaching to the posterior wall of the third deciduous

FIGURE 7.

Radiograph of the mandible of a newly-born pup showing the condylar bone formation.

molar socket. On the same level as the anterior part of the cylinder is the crypt for the first permanent molar and behind the crypt is the mandibular foramen (*Fig.* 7).

In the mandible at about four and a half months the formation has disappeared to a considerable extent though much of its

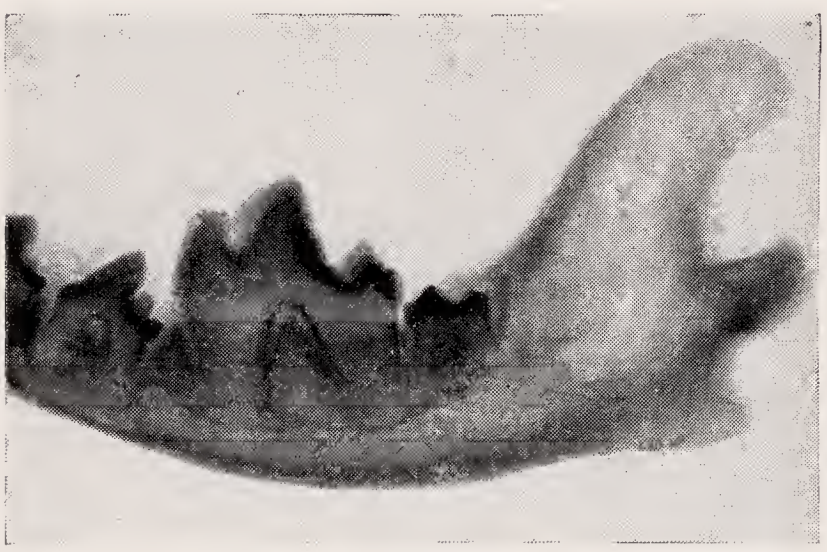


FIGURE 8.

Radiograph of the mandible of a dog of four and a half months showing the condylar bone formation.

former outline can still be seen (*Fig.* 8). The second permanent molar now occupies the same relative position to the formation as the first permanent molar did in the younger jaw and the mandibular foramen keeps its original relation to the formation. Here again, therefore, the crypts for the successive permanent molars and the mandibular foramen keep a definite and close relationship to the condylar bone formation.

From the foregoing descriptions it is apparent that the condylar bone formation is, in each case, very similar in general form, position and relations. It has disappeared in each case before the adult condition is reached. While it persists, however, it demonstrates the line on which the mandible grows in length and the ramus in height.

Further Growth Changes in the Condylar Formed Bone

If the condylar bone formation is examined closely in the X-ray pictures, it will be realised that from its first appearance and while it persists, it is distinct not because it is a solidly formed area of bone but for the very opposite reason. It is a lightly constructed formation which shows clearly, partly because it is outlined by the more densely formed bone deposited against it, and partly because the trabeculae forming it have the same general direction.

In those older specimens where a part of the condylar bone formation has been absorbed, the difference in density between the track of the formation and the surrounding bone is still maintained. This can be seen in the sheep at about three months where the anterior part of the formation is being absorbed (*Fig.* 6). Again, knowing the position occupied by the formation in the mandible of the dog during growth, it can be seen that in the animal at four and a half months it has become a lightly constructed part of the jaw (*Fig.* 8). After the formation commences to fade out in the human mandible during the latter part of the first year, a similar appearance is gradually produced; the track of the former formation in the ramus is lightly outlined by the organization of trabeculae above and below it. An early stage in this process is shown in a

mandible of sixteen months (*Fig.* 9). The full development of this appearance is shown in a mandible of six years (*Fig.* 10). Bearing in mind the relation of the crypt for the first permanent molar, the inferior dental canal, and the mandibular foramen to the formation while it is still visible, the coincidence of the now lightly formed area with the preceding condylar bone formation is evident. In the mandible of six years the crypt for the second permanent molar can be seen in the same relative position as was formerly held by that for the first permanent molar; the first permanent molar itself being now ready for emergence into the mouth cavity. During the eruption of the second permanent molar the third molar contained in its crypt will, in turn, come to occupy this same relative position, that is, above the condylar formation or the track formerly occupied by it. (*Fig.* 11). So during growth the track of the condylar bone formation reaches from the condyle through the ramus into the body of the mandible, in line with the inferior dental canal, and with the crypts for the permanent molars developing in turn above it.

Naturally in those mandibles where the attached masticatory muscles have been powerfully developed, the muscular flanges above and below the track of the condylar bone are strongly formed, and so the trabeculae of these areas outline it very distinctly. Thus in primitive mandibles, such as that of an Eskimo (*Fig.* 12), and a Negro (*Fig.* 13), or those of a Flat-Head Indian and an Eskimo figured by Walkhoff (1902), this has happened to such an extent that the heavily outlined track gives the appearance of a tube of bone running from the condyle through the ramus. It was this striking appearance in the mandible of an Australian aboriginal (*Fig.* 14) that caused Gullberg and Burkitt (1924) to elaborate the idea of a fundamental bony tube in the ramus. This idea in a less definite form had been earlier suggested by Walkhoff (1902) from a consideration of such human

FIGURE 9.
Radiograph of human mandible of sixteen months.

FIGURE 10.
Radiograph of human mandible of six years.

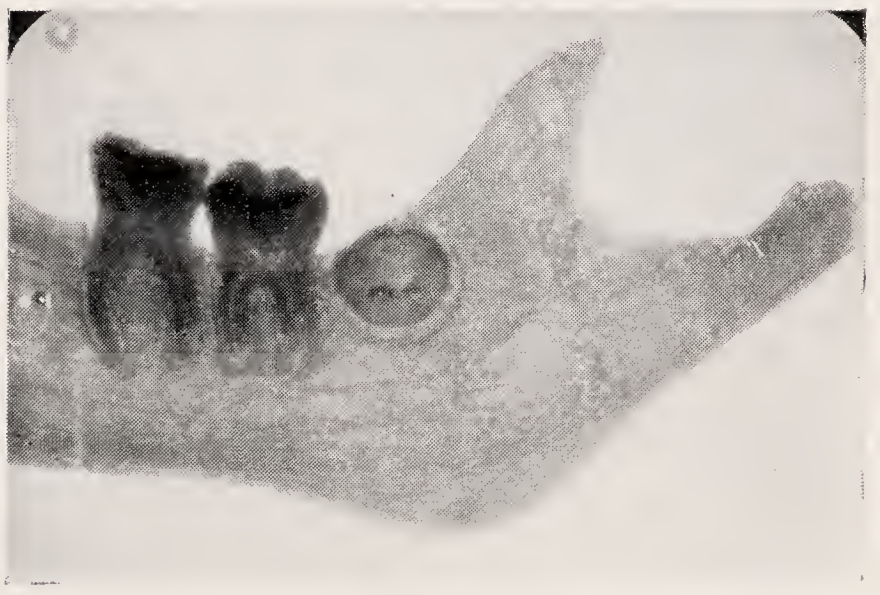


FIGURE 11.
Radiograph of human mandible of about fourteen years.

FIGURE 12.
Radiograph of the mandible of an Eskimo.

mandibles and also those of the anthropoid apes. At the time that both these suggestions were made, the importance of the condylar growth mechanism in mandibular growth had not been demonstrated. So naturally, being unaware of this developmental aspect, the explanation by Gullberg and Burkitt of this feature was entirely based on a mechanical conception.

A further good example of this appearance is provided by the Piltdown mandible. The X-ray picture of the mandible as figured by Underwood (1915) shows the tube-like bone formation, passing from the condyle forwards and downwards through the ramus into the body of the mandible. The interior of this formation is very lightly constructed, and as before, it is the outlining more densely formed bone which produces the tube-like appearance.

It would appear therefore that the condylar bone formation is lightly constructed from its first appearance and subsequently through the slower increments of the bone at the condyle and the gradual absorption of the older bone in the re-organization of the internal structure of the mandible it fades out, yet its former track remains as a lightly formed area. This absorption occurs after the condylar bone formation has served its purpose as the principal means of lengthening the mandible and producing at the same time the height of the ramus, and as a basis on which membrane bone may be deposited for other purposes, such as muscular attachment areas. Thus the track in which the condylar bone is laid down is one of light stress and remains more obviously so after the condylar bone has been largely absorbed. Nevertheless, this track is part of the fundamental basis of the mandible and as such is continuous with the bone forming the primary mandible body. Moreoever this fundamental basis of the mandible bears a definite relationship to the mandibular foramen and to the successive crypts for the permanent molar teeth.

The Form of the Mandible

The fundamental basis of the mandible

FIGURE 13.
Radiograph of the mandible of a Negro.

is of course identical with the mandible proper as defined earlier. In the adult human mandible, it extends downwards and forwards from the condyle as a lightly-built track, through the region of the mandibular foramen into the body of the mandible, where it surrounds the inferior dental canal. Anterior to the mental foramen it similarly surrounds the incisive nerve to the region of the symphysis. To this basic part the secondary elements of the mandible, as defined earlier, are added, producing a harmonious functional whole. Since the rest of the mandible is built around this basic part it seems reasonable to assume that an adequate comparison of different mandibles might be made by their superimposition with this basic part used as a common line; and that by this comparison something might be learned of the end to which the functional whole is built up.

For this superimposition it was decided to employ the ramus part of the mandible proper, since the greater part of the mandible proper is formed by the condylar growth mechanism, and the condyle is the only " fixed " part of the mandible. Moreover, this is the most easily defined part of the mandible proper, the mandibular foramen being the only obvious landmark for it on the jaw apart from the condyle. It may be re-emphasized here that the mandibular foramen is always in close relationship to the basic element of the

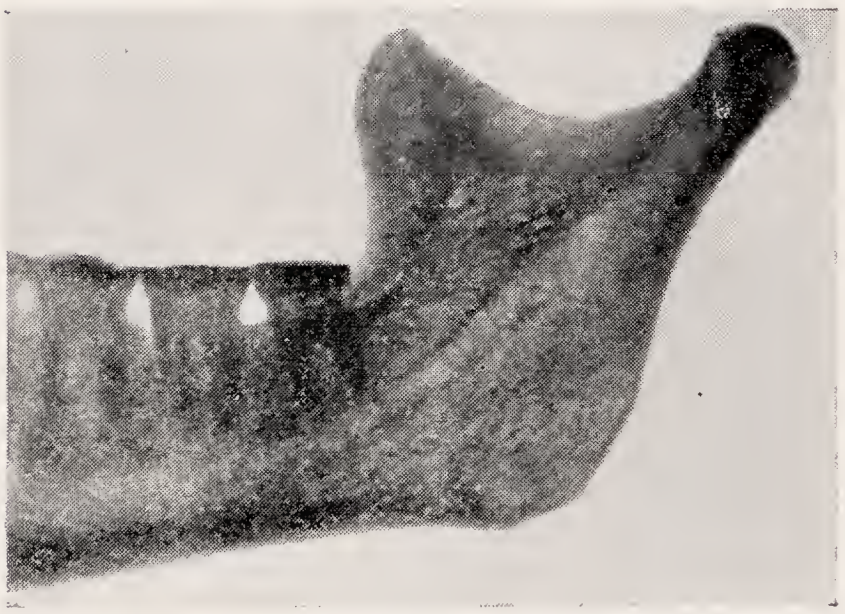


FIGURE 14.
Radiograph of the mandible of an Australian Aboriginal (Gullberg & Burritt).

mandible. This is well shown in an X-ray of the human mandible of sixteen months taken with a lead marker placed at the mid-point of the foramen (*Fig.* 15).

FIGURE 15.

Radiograph of human mandible of sixteen months with a lead marker placed at the mandibular foramen showing its close relationship to the condylar-formed bone.

The materials used in this part of the work were well-formed adult human mandibles with full or nearly full existing dentitions, only those jaws with the premolar and molar teeth present being included. No jaws were included in which the premolars and molars had not been functional. The specimens filling these requirements, of which there were fifty-two, came from widely distributed sources. As well as a number of European origin, Negro, Bantu, Australian aboriginal, Patagonian, Eskimo, Sinhalese, and various types of Indian jaws were amongst those represented. No attempt was made to separate the specimens into racial or territorial groupings as the numbers in each case were too small to be of any value.

For simplicity in the actual superimposition and to facilitate the taking of any measurements that might be required, it was decided to represent each mandible by an outline drawing. An accurate outline of the left half of each mandible was obtained radiographically. The mandibles were placed in a standard position arrived at as follows: the jaw was so orientated that (1) the lower borders of its two sides were in the same horizontal plane at a right angle to the film, and (2) the posterior borders of the rami were in the same vertical plane at a right angle to the film. An X-ray was taken of each bone in this position, with a target-film distance of eight feet, the central ray being arranged to fall perpendicularly to the film. Lead markers were placed on the outline of the left side of each jaw so that it could be easily distinguished on the X-ray. A lead marker was also placed on the left ramus of each jaw at the mid-point of the mandibular foramen.

Outline tracings of the left half of each jaw were obtained from the X-rays and on these the following comparable points were marked:—

X.—*The centre point of the head of the condyle, estimated on the outline tracing.*

Y.—*The position of the mandibular foramen, indicated by the lead marker.*

A line X-Y joining these two points represents the axis of the ramus part of the mandible proper. When several of the outline tracings had been superimposed by means of this line with X used as a common point it appeared that the occlusal planes of the teeth always fell parallel to one another (*Fig.* 16). In order to verify this

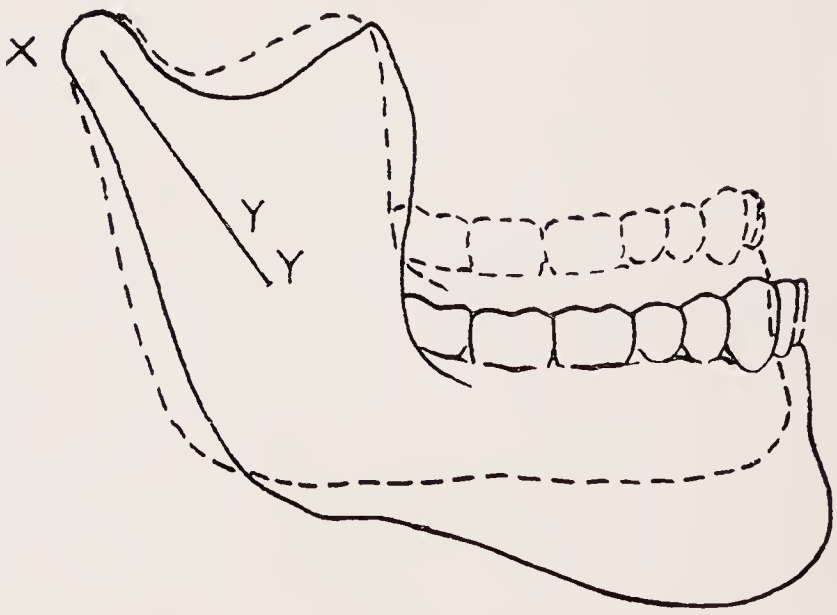


FIGURE 16.

The outlines of two mandibles superimposed on the line XY with X as a common point.

and to ascertain the amount of deviation amongst the specimens, the angle was measured that would be formed by the line X-Y and the occlusal plane. This is angle A in Fig. 17. The occlusal plane was represented by a line joining the point where the outline of the occlusal surfaces of the second and third molars met, with the point where the outline of the occlusal surfaces of the first and second premolar met on the X-ray. This angle was measured on the actual X-rays and the results are shown in TABLE 1.

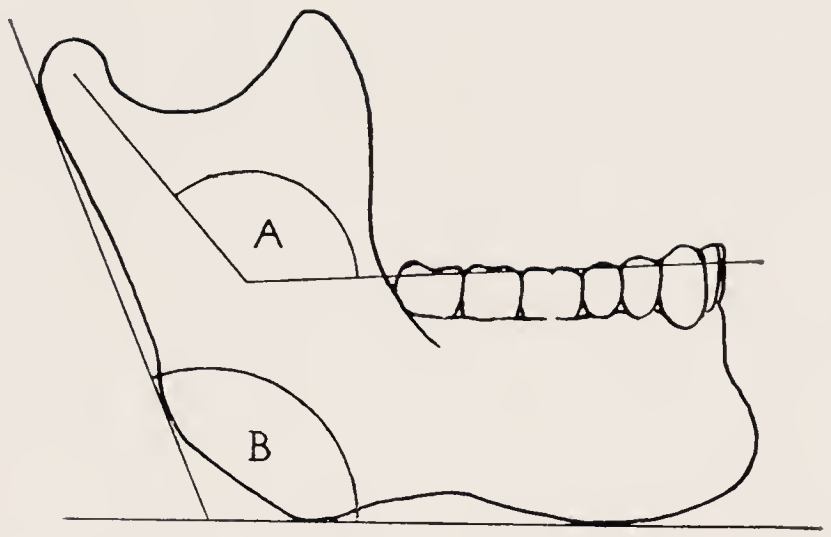


FIGURE 17.
Diagram illustrating the measurement of ∠A and ∠B.

TABLE 1

	ANGLE A	ANGLE B		ANGLE A	ANGLE B
	°	°		°	°
1	125·0	112·5	27	130·5	123·0
2	126·0	127·0	28	118·0	113·5
3	128·0	129·0	29	126·5	118·0
4	121·5	110·0	30	114·0	108·0
5	129·0	128·5	31	119·5	113·0
6	128·0	117·5	32	118·5	124·0
7	128·5	125·5	33	119·0	118·5
8	121·5	117·0	34	118·0	120·0
9	121·5	123·5	35	123·0	114·0
10	116·0	113·5	36	120·5	118·5
11	124·0	127·0	37	118·5	110·0
12	120·0	114·5	38	123·5	134·0
13	128·0	125·5	39	120·5	113·5
14	121·5	111·5	40	127·0	123·0
15	122·0	112·0	41	130·5	115·0
16	125·5	134·0	42	120·0	112·5
17	127·0	133·0	43	126·5	126·0
18	118·0	116·5	44	124·5	132·5
19	121·5	127·5	45	129·5	123·0
20	127·0	132·0	46	120·5	118·5
21	123·5	118·5	47	123·5	112·0
22	128·0	137·0	48	117·0	102·5
23	128·0	122·5	49	124·0	127·5
24	126·0	125·0	50	124·0	123·0
25	128·0	130·0	51	119·5	115·5
26	120·5	126·0	52	123·5	111·5

Mean value of angle A = 123·25°

Mean value of angle B = 120·65°

It will be seen from this table that the variation of angle A is small, the extreme range of individual variations being from 114·0° to 130·5°, while the standard deviation, itself a measure of the amount of variation is 4·1°. In order to provide a means of comparison by which the small range of angle A might be demonstrated the mandibular angle, angle B in Figure 17, was measured on the X-rays over the same series of mandibles. The results obtained are given in TABLE 1. In this series of jaws the values for the mandibular angle extend from 102·5° to 137·0°, a range of 34·5°. The standard deviation for this angle is 7·75°. There is a significant difference (at the 0·001 level) between the standard deviation for angle A and that for angle B, and it follows that the variation of angle A is significantly less than the variation of angle B. It should be pointed out that the mandibular foramen though bearing, as has been shown, a close relationship to the condylar formed bone is at best only an approximation to its position, and has been used as being the only other possible landmark for it, apart from the condyle, in the adult mandible; furthermore there is a certain error possible in the placing of the point representing the mandibular foramen. Thus there is likely to be an experimental error introduced in the measurement of angle A, while on the other hand angle B, the mandibular angle, can be very accurately determined. In view of this the significant difference between the standard deviations for these two angles takes on a greater importance. The angle A then may be considered as being relatively constant (in so far as any human measurement can be considered as having constancy[1]). In other words the body proper of the mandible forms a relatively constant angle with the occlusal plane. On this analysis the form of the mandible would be essentially dictated by its basic element, the mandible proper, and the angular relationship which this bears to the occlusal plane. The alveolar bone then must be considered as a " filling-in " bone between the basic element and the occlusal plane. It would seem therefore that it is the lower jaw which adjusts itself to the form of the upper jaw; this adjustment being carried out in two ways:

(a) *by the angulation of the mandible proper to the occlusal plane.*

(b) *by the building-up of the alveolar bone.*

It has long been a common desire amongst investigators of skull growth and especially of the facial skeleton to find a fixed point or plane from which measurements could be made. This would appear to have been taken as far as it is possible in the ever-changing field of bone growth by the X-ray cephalometric technique of Broadbent, which now provides a valuable aid in orthodontic diagnosis. More recently the search has shifted to the finding of some angular relationship between skull parts which could be utilized in the comparison of different individuals. Such would seem to be the basis of the investigations of Tweed and Margolis. To the orthodontist such angles are of value and particularly so would be one which remained constant throughout the range of normal individuals. It is suggested that the angle described, formed by the mandible proper and the occlusal plane, with a mean value of 123·25°, goes some length in the filling of this requirement.

SUMMARY

In this work the mandible has been resolved on developmental grounds into a basic element, the mandible proper, to which the other, secondary, parts are added, these secondary parts being definable on functional grounds. The whole is

[1] *According to Broadbent* (1927), *standing height is the least variable of all measurements in man, and the coefficient of variation of standing height is* 3.5. *The coefficient of variation of angle A obtained from the* 52 *mandibles employed is* 3.3.

built up against the occlusal plane to which the ramus part of the basic element bears a relatively constant angular relationship. It has been suggested that this angle may be of value in orthodontic practice.

I wish to thank Professor D. R. Dow of University College, Dundee, Professor R. D. Lockhart of Marischal College, Aberdeen, and Professor T. Walmsley of The Queen's University, Belfast, for the use of material from their departments. My thanks are also due to Dr. T. E. Faulkner of University College, Dundee, for the statistical work involved.

REFERENCES

Bluntschli, H. & Winkler, R. (1927). *Handbuch der normalen und pathologischen Physiologie*, Bd. 3, S. 295. Berlin: Julius Springer.

Broadbent, B. H. (1927). *Dental Cosmos.* **69**, 797.

Charles, S. W. (1925). *Brit. Dent. J.* **46**, 845.

Fawcett, E. (1924). *The Growth of the Jaws, Normal and Abnormal, in Health and Disease.* p. 7. London: Dental Board of the United Kingdom.

Gullberg, J. E. & Burkitt, A. N. (1924). *J. Anat. Phys.* **59**, 41.

Low, A. (1909). *J. Anat. Phys.* **44**, 83.

Rushton, M. A. (1944). *Brit. Dent. J.* **76**, 57.

Rushton, M. A. (1948). *Trans. B.S.S.O.* 13.

Underwood, A. S. (1915). *Dental Cosmos.* **57**, 125.

Walkhoff, O. (1902). *Der Unterkiefer der Anthropomorphen und des Menschen in seiner funktionellen Entwicklung und Gestalt. Selenka's Menschenaffen—Studien über Entwicklung.* Wiesbaden.

Dr. James Scott, after his reading of the paper, said that to his mind the chief feature of it was that it gave a logical developmental analysis of the mandible. One was no longer left in the dark with vague terms such as "basal bone" and "alveolar bone" but had a much better idea of the mandible and its parts.

Before ending, he might perhaps say something of the muscles and their relation to the mandible. This was not part of Mr. Symons' work, but fitted in with it to some extent.

There had been a good deal of discussion of late as to the part played by the muscles on the development of occlusion. The muscles that acted upon the mandible fell into two groups—the muscles of mastication, the temporal masseter and pterygoids, which were related to the back part of the mandible and not attached directly to the basal mandibular bone but to special processes of that bone; and the muscles including those of the face, the most important of which was the buccinator and the muscles of the lips, and those of the floor of the mouth, including the mylohyoid, genio-hyoid and muscles of the tongue. These muscles had diverse functions related to mastication, swallowing, suckling and speech. The important point was that they were attached to the basal and not to the alveolar part of the mandible.

In the upper jaw, again, no muscle was attached to the alveolar part. They were attached to what might generally be called the basal part of the bone, although the analysis of the upper jaw had not been carried out in the manner in which Mr. Symons had analysed the lower jaw.

These muscles did not act directly on the alveolar bone: they acted on the basal part of the mandible, and it was well shown, he thought, from Mr. Symon's paper that the basal part of the mandible was quite distinct in development, function and form from the alveolar part.

DISCUSSION

THE PRESIDENT said everyone must have admired Dr. Scott's mastery of the subject, particularly as his contact with the author had been limited to the weekend.

He himself had had the good fortune to be in touch with Mr. Symons when he was working on his material at Belfast before his translation to Dundee. He (the President) attached considerable importance to the paper, the orthodontic application of which had still to be worked out. It seemed remarkable that in the extraordinarily variable and individual human face, there should be such a degree of constancy in the particular angle Mr. Symons had defined. The variation in the angle between the line joining the condyle and the dental foramen was far less than that of any other angle he had come across in connection with the face.

Dr. Tweed in the United States had attracted a good deal of attention by his attempt to define the relationship between the angle of the lower incisors and that of the lower border of the mandible. As Mr. Symons had demonstrated, however, the lower border of the mandible had a very variable relationship. Dr. Tweed seemed to have been putting in somewhat different shape what he (the President) and many other orthodontists had been doing for a considerable period—relating the angle of the incisors to the plane of occlusion. He suspected Dr. Tweed's statements would be more exact in their application if he made reference to the occlusal plane of the mandibular cheek teeth rather than to the lower border of mandible. This would have to be tested, but in the light of Mr. Symons' paper it seemed likely to be the case.

Dr. Scott had given his commentary on the paper, and the meeting was now open for general discussion.

MR. PRINGLE said a good many people would be interested in the measurement of this new angle. It would therefore be as well to be quite clear what Mr. Symons meant by the occlusal level. It varied a good deal. Were the incisors included, or how did he fix it? People would want to check his measurements with their own.

DR. SCOTT said the best answer to this question would be to read the relevant passage from the paper: "The occlusal plane was represented by a line . . . premolars met."

The line was drawn between the contact points of the second and third molars and the contact joints between second and third premolars and extended backwards and forwards from them, backwards to the growth line and forwards to cut the incisors.

THE PRESIDENT added that originally Mr. Symons had taken the alveolar border and in that way he had established a constant angle. At a later stage he took the occlusal plane of the molars and premolars. It was very significant that no matter how one took it—whether alveolar border or occlusal surface of the molars and premolars—one obtained this very high degree of constancy in the angle.

MR. CHAPMAN asked Dr. Scott to enlarge on the point that the root of the canine in a new born sheep was in contact at a very early period with the first deciduous molar. A little later on there was an enormous gap between the two. How did it come about? It made one think of interstitial growth, though he did not believe there was such a thing. This gap reminded him of the gap frequently seen in human dentitions between the canine and the first upper premolar and sometimes between the lower canine and first premolar, a gap that was present in both normal and abnormal cases.

He also asked for a little more clarification with regard to the occlusal line. He gathered from what Dr. Scott had said that there had to be more alveolar growth in the front.

DR. SCOTT, in reply to the second question said the basal element of the mandible, which was divided into the anterior

neutral part and the posterior cartilage part, might be represented in this way: the alveolar bone was built up in this manner. It meant that there was a greater amount of alveolar bone substance in front than in the back region. This applied to most mandibles, though there were exceptions and it would, of course, depend on the presence or absence of teeth. One could have a mandible in which the growth line was more vertical. If the angle were taken as 137°, there would have to be a great build-up of the alveolar bone, but if the line of growth were more horizontal—say 130°!—there would be less need for growth in the front part of the mandible. That was to say, the amount of build-up in the alveolar front part would depend on the direction of growth of the mandible itself. In general, there was need for a greater amount of alveolar build-up in the front than at the back.

Mr. Tulley said that he presumed the mandibles, from which Mr. Symons has taken his measurements, were from various races and from skulls with normal occlusion.

Secondly, he would like Dr. Scott's views on the function of the Buccinator. Although it is not attached to the alveolar portion of the bone it was part of the leash of muscles passing back continuous with the constrictors of the pharynx, the interesting point being that the posterior attachment of the constrictors is to the basiocciput which is behind the spheno occipito-synchondrosis.

He was very interested in its effect on the dental part of the facial skeleton during growth.

Dr. Scott said Mr. Symons had drawn on various types, including people of European, Negro, Bantu, Australian, Aboriginal, Eskimo, and Senegalese origin. Mandibles were selected as isolated bones, and in very few cases were they matched with upper jaws. It was not possible, therefore, to pronounce on normal occlusion. He had, however, made a point of taking mandibles in which all the teeth were present and in which—from the point of view of the mandible—all the teeth seemed to be more or less normal in arch form.

The buccinator was one of those intriguing subjects about which one could talk indefinitely. It is attached to the body of the bone along a line running forwards and downwards towards the mental foramen.

The buccinator involved not only the mandible itself but also the ligament between the mandible and the medial pterygoid process and then through its continuity with the superior constrictors it was attached to the occipital bone. All kinds of growth change might be taking place there—growth and height. It was separating its attachments to mandible and maxilla, and there was also the stretching of the pterygoid and mandibular ligament. Because of the growth, therefore, there must be a continual expansion of the muscle so that it could keep on surrounding the growing pharnyx.

This raised the question of the relationship between growing muscle and growing skeleton. There were two extreme points of view. One could say the muscle determined the skeleton. One might be right or wrong, but this was the kind of statement some orthodontists would like to believe.

The other extreme point of view was that the growth of the skeleton determined the growth of the muscles. This was a more anatomical attitude. Most anatomists today would say that the skeletal growth was the important factor and that the muscles simply adjusted themselves to it—that the length of the muscle was determined by the growth of the skeleton.

There were plenty of fascinating problems to be worked out in the relations between muscles and skeletons. It was no use, in his view, making one extreme statement or the other at the present time.

Mr. Ta'Bois asked from how many centres the mandible calcified. Sir John Bland-Sutton gave six, he believed, and Fawcett one for each half of the mandible.

Dr. Scott pointed out that Sir John Bland-Sutton was trying to support an idea common in his time that the mammalian mandible was a derivative of the reptilian mandible. The latter was built up of a number of quite different bones. The evolutionists in Bland-Sutton's time would naturally want to find as many indications as possible of the idea that human structures developed from earlier reptilian structures, and in those days anatomists spent a great deal of their time searching for evidence to support this theory.

The safest course at present was to teach students that the mandible consisted of three quite distinct elements—the membrane bone element, the Meckel's cartilage element, and secondary cartilage elements. The front end of Meckel's cartilage was incorporated in the mandible. It became ossified. One could see the tissue penetrating into the cartilage and the bone coming in and replacing the cartilage. It was as good an example anywhere in the body of cartilage being replaced by bone. From the canine back to the mandibular foramen there was a blank in our knowledge.

Mr. Leech, referring to the attachment of the buccinator to the body of the bone as distinct from the alveolar part, asked whether Dr. Scott could differentiate histologically between the two.

Dr. Scott said he could best deal with this difficult question by taking a typical adult long bone, such as the femur. Histologically there was no difference; the whole femur was the same type of bone. But if one looked at its development, one found it was partly in membrane and partly in cartilage. First of all, the typical long bone was all cartilage. Then membrane bone was laid down as a kind of splint between the periochondrium and the surface of the cartilage. When the perichondrium became periosteum, there was an invasion process and the cartilage was replaced by bone. Developmentally and histologically at that stage the femur was partly membrane bone and partly cartilage bone. On examining an adult femur, however, "histologically" there was no difference in the bone arising in these different ways.

There might be a structural difference. The structure of any bone was partly hereditary and partly the result of the action of the muscles, weight-bearing, and other forces. The way in which the trabeculae ran in a bone was a combination of these two elements. He did not know to what extent one could say that the contribution of one of them was the more important. A common feature in dental literature was the sort of article with a paragraph about mechanics and cranes and loads and weights and then the main part of the article. But it was not so smooth as that because femurs could be developed outside the body which not only had the general form of femurs but developed a certain structure of their own. One very attractive possibility that appealed to him—though it was not scientific but purely philosophical—was that there was, putting it crudely, change during evolution, but in addition to the building of new structurals the body cells repeated phases of development which were related to the function of the part during some earlier stage of evolution, but not any of apparent relation to function at a later stage.

Mr. Norman Gray said Dr. Scott had given them a most fascinating evening, but he had only pushed the mystery of growth one step further back. Could Dr. Scott say anything that would illuminate the problem of anterior open bite? A lot of us have notice clinically in these cases that there could be perfectly normal growth in the molar and premolar region with complete lack of growth in the premaxilla.

If one drew an imaginary line along the occlusal plane of the upper molars and premolars and continued it forward to the incisors, it would show a huge gap in the vertical growth of the lateral and central incisors.

Dr. Scott said this was some kind of failure of growth. It was common to think of growth as a matter of bone. Orthodontists tended to think of failure of growth as a failure of bone formation. Perhaps they were not going sufficiently deep to find a useful answer to the problem. Bone was simply a secretion into a tissue. If the tissue in which it was secreted did not grow, the bone would not grow. Anatomists had now repented of their original sins and realised that the organic content of bone was important both for growth and for other things in the calcified deposits it produced.

A vote of thanks to Mr. Symons and Dr. Scott, proposed by the President, was carried by acclamation, and the meeting then terminated.

The Human Jaws and Dentition

The Northcroft Memorial Lecture, 1950 *

FREDERIC WOOD JONES,* D.SC., F.R.S., F.R.C.S.

WHEN JOHN HUNTER wrote his great work on the teeth, he introduced it with the observation that " Before we enter into a description of the teeth themselves, it will be necessary to give an account of the upper and lower jaw-bones, in which they are inserted." John Hunter realised that any deductions made from the examination of isolated teeth were likely to be but little profitable, for teeth and jaws constitute a functional unit. As he says, " The alveolar processes of both jaws should rather be considered as belonging to the teeth, than as parts of the jaws; for they begin to be formed with the teeth, keep pace with them in their growth, and decay and intirely disappear when they fall."

With this typically Hunterian conception of the unity of teeth and jaws no one, whose preoccupation is with animal structure, is likely to disagree. Indeed, George Northcroft, in whose honour this lecture is given, is best known to anatomists by reason of the clarity of his expression of the relationships of teeth to the growth of the jaws. Unfortunately, it is no longer possible to dismiss the jaws with a simple anatomical description of their characteristic features, as Hunter did. For Hunter had the good fortune to live in an age that knew not the doctrines of the archaetype and was innocent of the falsifications of the post-Darwinian morphologists.

In the study of any anatomical problem, it must always be remembered that after Hunter had demonstrated his great clarifying concept—that function and structure must be studied as a unit and that structure was merely the overt expression of function—many academic theories of animal structure were promulgated and these have had their influence upon the trend of thought in all matters relating to biological studies. Two of these academic concepts cannot be passed over if we are to understand the fundamental teaching concerning the nature of the jaws. The first that we need notice is that of the archaetype. It was Goethe, the poet-philosopher, who first saw, with remarkable clarity, that both plants and animals were, so far as their structural components were concerned, composed of a series of elements arranged along the long axis of growth. These elements were modified in different regions of the body in order to fulfil the demands of functional activities. In the plant were leaves, bracts, sepals, petals and finally the cephalised expression of these elements in the flowers. In the animal were simple vertebrae with specially developed processes and finally the cephalised expression in the skull, composed of compressed, coalesced and modified vertebrae. The theory of the archaetype was an intellectual triumph and provided an academic concept that, had it been confined to its proper sphere, would have proved a great co-ordinating principle in biological studies. Unfortunately, as is so often the case, it was pressed too far by its enthusiastic exponents and, instead of being regarded merely as an intellectual

*Presented at the meeting on 13th November.

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concept, it was accepted as the explanation of the actual condition of all sorts of structural features in both plants and animals. In the heyday of the archaetypal theory—the period of transcendental anatomy—the anatomist regarded the lower jaw as being " the costo-sternal element of the third cranial element." The temporo-mandibular joint was regarded as the cranial representative of the costo-vertebral joint of a typical thoracic segment. In the same way the maxilla was homologised as the costo-sternal element of the fourth cranial vertebra. It may be said that even if the establishment of these homologies is no very helpful thing in the practical study of anatomy, it must at least be admitted that it leads to no temptation to distort the facts of ontogeny and phylogeny in order to make them fulfil the demands of a theory. For some twenty years following 1848, the archaetypal theory reached gigantic proportions and, as Thomas Dwight said, "it soon became nothing short of a night-mare." But with the spread of the doctrines of Charles Darwin, it fell with a crash. The transcendental anatomy of the archaetype period was replaced by the "morphology" of the post-Darwinian anatomists who were concerned mainly with the quest for support of Haeckel's " biogenic law." If the archaetypal theory may be termed a harmless academic dream that led to no distortion of actual anatomical fact, such a judgment most certainly cannot be passed upon post-Darwinian morphology. The construction of phylogenies and family trees was one of the major preoccupations of the immediate followers of Charles Darwin and, spurred on by Haeckel's dictum that ontogeny recapitulates phylogeny, they sought for (and found) perfect confirmation for their theories in the embryological story of man. It is not an exaggeration to say that this business of finding confirmation for assumed phylogenies in actual ontological stages, resulted in what can only be termed deliberate falsification of the ontogenic phases of many animals and above all of Man. Not until our studies in ontogeny are purged from all preconceived bias of phylogenetic interpretation will embryology become a real science.

In following Northcroft in discussing " The Teeth in Relationship to the Growth of the Jaws," it is perhaps best at the outset to declare an adherence to two theses. The first is that among the Vertebrates, the lower jaw of the Mammals is a structure basally different from the jaws of sub-mammalian Vertebrates. The second is that among mammalian upper jaws the human jaw is unique in its constitution.

In 1931, the Russian biologist Sewertzoff introduced the term "aromorphosis" as defining those changes which occur from time to time in the paleontological story of living things, that produce profound effects by opening up a whole new series of possibilities of development. Minor variations and adaptations occur with great frequency but they effect, at the most, only more perfect adaptation of the living thing to its mode of life. Aromorphoses occur but rarely, but they lead to profound changes by virtue of the possibilities they offer for further advance. In defining an aromorphosis Zeuner (1946) has instanced the development of the Gnathostomes from Cyclostomes and he says, "One of the most important aromorphoses in the evolution of the Vertebrates was the conversion of one or several gill arches into the biting apparatus of the jaws." It is in connection with the processes of developing the permanent bony jaws from the embryonic cartilaginous pharyngeal arches that the anatomist is concerned. The early stages of the transformation, as seen in the embryos of the sharks, have long been well known and are almost diagrammatically simple (*see Figure* 1). With the flexure of the embryonic head on the long axis of the body the first pharyngeal arch becomes bent into a dorsal limb, best

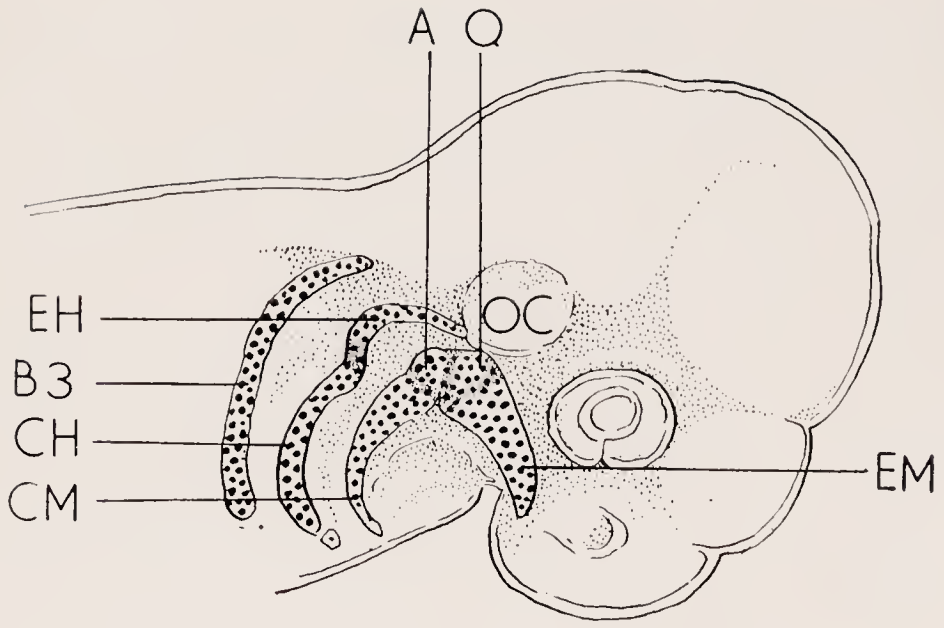

FIGURE 1

Head region of an embryo Dog-fish (Scyllium canicula) of 18 mm. (Simplified from Parker, Trans. Zool. Soc. Vol. & 1879 Pl. 34. Fig. 1)

EM = epimandibulare.
CM = ceratomandibulare.
EH = epihyale.
CH = ceratohyale.
B.3 = third branchial arch.
A & Q = bases of articulare and quadrate.
OC = otic capsule.

termed the epimandibulare, and a ventral limb, the ceratomandibulare. At the point at which the bending takes place, in the region of the otocyst, two separated portions may be isolated so as to form a hinge between the epimandibular and ceratomandibular parts of the cartilaginous arch. In the same way a kink develops in the second or hyoid cartilaginous arch and differentiates the epihyale, in close apposition to the otocyst, from the long ventral extension, the ceratohyale. The third pharyngeal arch does not share in this bending and remains in its primitive form. The two dorsally separated portions of the first arch that are adjacent to the otocyst form the bases of the quadrate and the articulare respectively; while the dorsal part of the hyoid arch—the epihyale—becomes the basis of the tympanohyal (hyomandibular) element. This amount of bending and segmentation of the first two pharyngeal arches permits of the gnathostomous condition, for the ceratomandibulare is free to move, by the intervention of the articulare and the quadrate, upon the epimandibulare and the jaws may be opened and shut. The second arch is permitted the necessary mobility, consequent on the movements of the lower jaw, by the articulation between the tympanohyal and the ceratohyale. With minor variations, such as the share that the tympanohyal (hyomandibular) takes in the actual attachment of the lower jaw to the skull, this arrangement holds good for the cartilaginous basis of the jaw in all fishes (*See Figure* 2). The cartilaginous lower jaw of the bony fishes undergoes a further development when bone becomes incorporated into its structure. Bone is developed not only by ossification occurring in the ceratomandibular cartilage itself but also by the addition of ensheathing

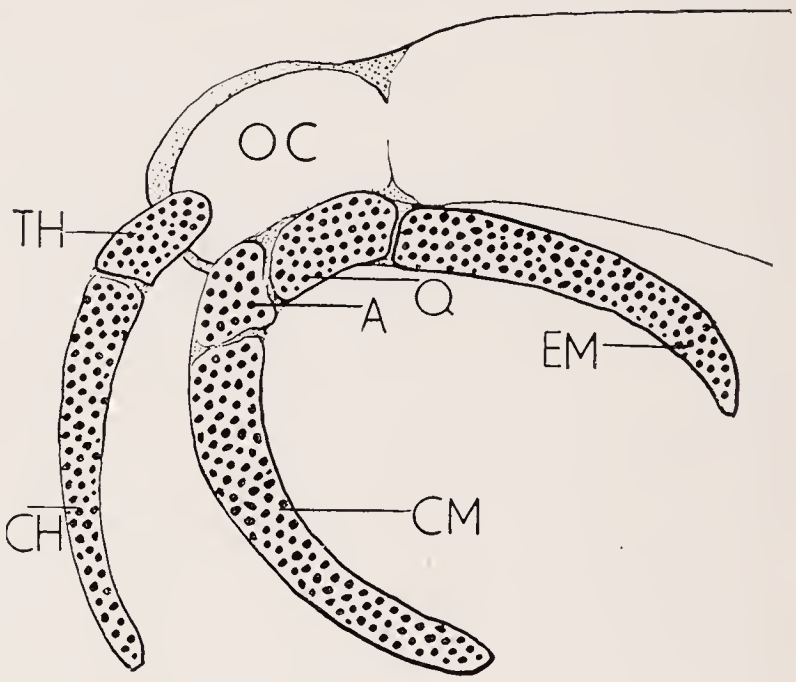

FIGURE 2

Diagram of the condition of the jaws of a water-living vertebrate. TH = tympanohyal. = epihyale, other lettering as in Figure 1.

membranous bones. Six separate bones may be developed in connection with the ceratomandibular cartilage in the Teleosts. The *articulare* and the *angulare* are developed as ossifications within the cartilage as is the *mentomandibular* (mentoMecke-

lian). The occasional *infraangulare* is probably in the same case as is also the *coronoid*. The *dentary* is, however, an added sheathing membranous bone, and it becomes an important constituent of the bony lower jaw. The clear fact is that the mandible of the fishes is a complex structure constituted of many bones developed within or around the cerato-mandibular cartilage. This jaw is hinged to the skull, in the region of the otic capsule, by the intervention of the quadrate with, in some cases, the incorporation of the hyomandibular (tympanohyal) as well.

In the perfected fish it is therefore necessary to realise the fact that the ceratomandibular has had its primitive cartilage replaced by bone developed within the cartilage or added to it as membranous splints. The piscine mandible is a bony complex composed of many separate elements that are still hinged to the skull in the region of the otic capsule by the intervention of the quadrate. The hyomandibular (tympanohyal) may make some contribution to the suspensorium of the mandible in specialised forms, but the autostylic suspensorium, in which the quadrate allne articulates the lower jaw to the skull is undoubtedly the primitive mechanism.

All fish are water-living creatures, their otocysts are largely concerned with the function of body poise and balance. No air-borne waves of sound come to them. We shall be in harmony with orthodox zoological views if we suppose that the conquest of the land was made by way of some such forms as the autostylic Dipnoi (Lung Fish). In these forms the hyoman-dibular (epihyal, tympanohyal) was a free and independent element attached to the lower and caudal aspect of the otocyst. The structural transition from the condition present in the water-living Lung Fish to that typical of the land-living Amphibians and Sauropsidians would appear to be a comparatively simple one. The compound ossified ceratomandibular is retained as the lower jaw and this lower jaw is hinged to the skull by the intervention of the quadrate. For the reception by the otocyst of air-borne waves of sound, a tympanum of some sort is developed and in order to convey the vibrations from the tympanum to the receptors of the internal ear, the unemployed hyomandibular becomes modified into the *columella*, the most ancient of the auditory ossicles (*see Figure* 3). Such a condition is present throughout all members of the sub-mammalian Tetra-pods.

But in the case of the Mammals a very different end result has been achieved and this result is evidently due to a very different series of transitional stages. It cannot be sufficiently stressed that the mammalian lower jaw is a thing sui generis, not derived from the sauropsidian jaw, but initiated independently of and developed differently from the compound ossification of the sauropsidian cerato-mandibular. The mammalian lower jaw differs from the amphibian and sauropsidian lower jaw in that (1) it is not an ossification of the ceratomandibulare; (2) it, therefore, does not articulate with the skull by the intervention of the quadrate, but makes an independent articulation with the temporal in front of the otic capsule and (3) it is not a compound structure formed of several separate elements; but consists of a single bone developed caudad of and lateral to the obsolete ceratomandibulare. The development of the human lower jaw as a single bone, independent of the ceratomandibulare had been described in minute detail by Robert Nesbitt in 1731. It had been accurately described and figured by Albinus, Callender and many other careful observers before Charles Darwin's followers, eager for the triumphs of the new science of morphology, sought in the development of the mammalian lower jaw fresh evidence in support of their assumed phylogenetic schemes. That the Mammals were

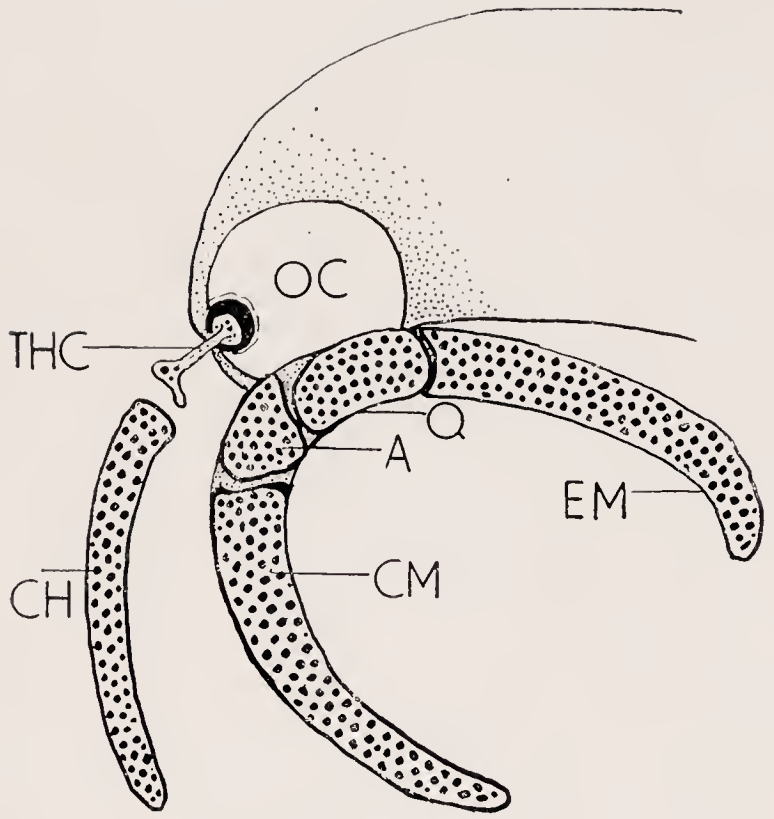

FIGURE 3

Diagram of the condition of the jaws of an air-living sub-mammalian vertebrate. THC = the columella, developed from the tympano-hyal and forming an auditory ossicle intervening between the tympanic membrane and the internal ear. Other lettering as in Figure 1

derived from the stock of the primitive Sauropsidians or from the Amphibians was the creed of the post-Darwinian morphologists; it was, therefore, certain that the mammalian lower jaw was derived from and had passed through the stages of the compound ossification of the ceratomandibulare. The correct findings of the older anatomists were disregarded and when, in 1883, Bland Sutton had completed his work on the problem, the teaching was firmly established that the demands of the biogenic law were fulfilled and that in its development the mammalian lower jaw passed through all the stages typical of the sauropsidian lower jaw and was compounded of all the elements present in the lower jaws of the sub-mammalian Vertebrates. In 1896 Quain's Anatomy taught the medical student that the ossification of the human lower jaw "takes place from several centres, which are united by the fourth month" and in 1898 Bland Sutton, in Morris's Anatomy, describes and localises, with an air of complete assurance, six centres (dentary, coronoid, condyloid, angular, splenial and mento-Meckelian) as being present in the human lower jaw. That the origin of the Mammals from sauropsidian or amphibian and ultimately piscine ancestors was guaranteed by the fact that even the human mandible was a compound of six different elements, remaining as separate entities until half way through foetal life, was the universal teaching at the end of the nineteenth century. It is the consideration of this example of an imaginary and incorrect account of developmental processes, put forward with complete assurance as to its validity, that justifies the expression "deliberate falsification of ontogenetic phases" that has been used previously. The mammalian lower jaw is composed, as the older anatomists rightly claimed, of a single bone and this single bone, not being developed in the ceratomandibular cartilage, has no connection with the homologue of the quadrate, but articulates primarily and always with the temporal bone. (*see Figure* 4) It is in this way that those elements of the epimandibulare and ceratomandibulare that are in

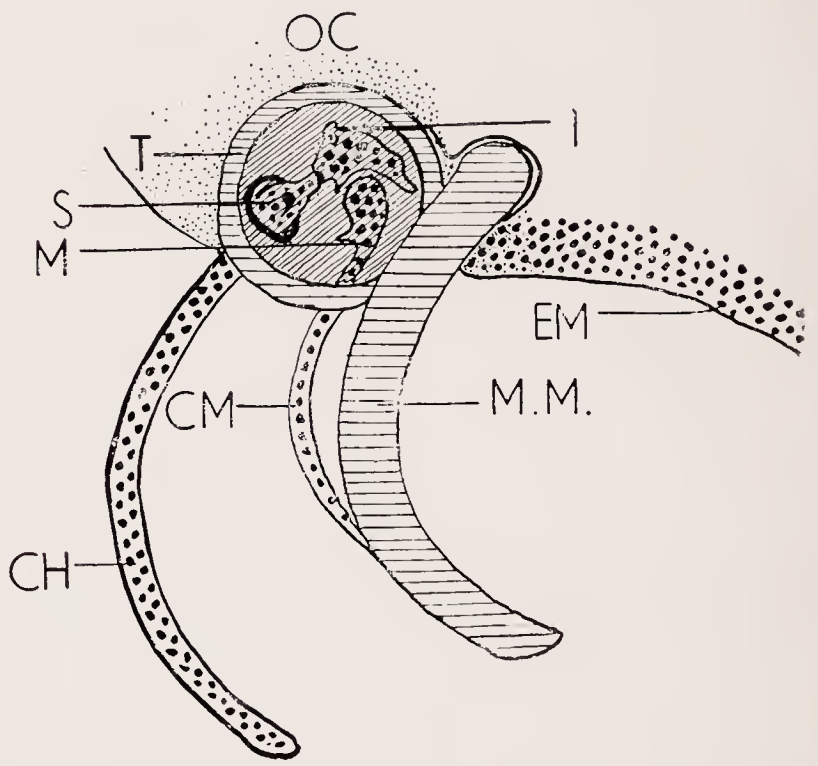

FIGURE 4

Diagram of the condition of the jaws of a mammal. T = tympanic bone. S = stapes (columella, tympanohyal). M = malleus (articulare). I = incus (quadrate). MM = mammalian mandible.

contact with the otocyst can take on the function, initiated by the columella (stapes) and become auditory ossicles for the conveyance of air-borne waves of sound from the tympanic membrane to the acoustic receptors of the internal ear. The malleus and the incus are now added to the stapes; and the tympanic bone (an element exclusively confined to Mammals) is developed. It must, therefore, be emphasised that the mammalian lower jaw is an element distinct from the sub-mammalian lower jaw and that the auditory ossicles of the mammals have never been part of the suspensorium of the lower jaw. Such teaching is contrary to modern dicta concerning mammalian phylogeny and it is perhaps to be regretted that, should it ultimately be accepted as orthodox, it will render invalid all the ingenious solutions of the paradox of the early Mammal, unable to hear because its auditory ossicles were not fully developed and unable to eat since its lower jaw had lost its old articulation and had not yet perfected a new one. But it may be questioned if all the ingenuity need have been expended on the question of the supposed change from the piscine, amphibian and sauropsidian lower jaw into the lower jaw of Mammals; for the problem of the lower jaw is not the only one involved in the transition. When an animal leaves an aquatic environment for a terrestrial one it has three major, and a host of minor, readjustments to make. (1) The first major adjustment is that it must perfect an air-breathing mechanism. It must take air into its coelom in order to permit of gaseous interchange between the air contained in lungs of some sort and the oxygen carriers of the blood stream. The submammalian tetrapods solved the problem by drawing air into lungs in an undivided coelomic cavity; but the Mammals are distinguished by the aromorphosis of the diaphragm. Much ingenuity has been expended in attempts to derive the mammalian diaphragm from something in amphibians, reptiles or even birds. But the conclusion that the diaphragm is a mammalian specialisation, not derived from any submammalian tetrapod form, seems to be the only one that can be justified by well known anatomical facts. (2) The second great adjustment consequent upon exchanging an aquatic for a terrestrial environment is that the animal must regulate its water intake, conservation and excretion in harmony with its liberation from a fluid medium. It is notorious that the mammalian kidney differs fundamentally from the kidney of the sauropsdians and that this difference is evidenced in the fact that while sauropsidians secrete uric acid in the form of a thick paste, the mammals secrete urea in the urine. In this regard the amphibians might be thought to help bridge the gap, for they, like the fishes and the mammals, excrete urea, but the bridge may be used no further, for it breaks down completely when the developmental phases of the mammalian lower jaw or of the diaphragm are considered. Indeed it will not serve even when limited to the kidney, for between the method of the excretion of urea by the amphibians and by the mammals there is a wide difference. As Homer Smith has observed: "The mammals have added the only important patent to the kidney since Devonian time; the capacity to excrete urine that is markedly hypertonic, or osmotically more concentrated than the blood." (3) The third great adjustment following the change from aquatic to terrestrial life was the necessity for conveying air-borne sound waves to the primitive otocyst. That the mammals solved this problem by developing a peculiar type of lower jaw and effected this change with the same independence as they had evinced in the development of the diaphragm and of the "intermediate segment" of the renal tubules, would seem to be abundantly clear.

In the case of the upper jaw there appear to be fewer complications in the developmental processes as the scale of the Verte-

brates is ascended. The epimandibulare becomes a stabilised part of the skull and both within the cartilage and around it are developed the individual bones of the upper jaw. The medial pterygoid and the palate may be regarded as ossifications within the epimandibulare and the maxilla and premaxilla are constant additions to it. Here the question of the agreement of ontogenetic stages with assumed phylogeny is not involved, for the mammalian upper jaw is formed on so generalised a vertebrate plan that affinities with any one of the submammalian phyla are not called in question. The mammalian lower jaw is unique among the lower jaws of vertebrates, but the mammalian upper jaw is of a generalised vertebrate type.

In the typical vertebrate upper jaw the most anterior element is the premaxilla (os incisivum, intermaxillary). (*See Figure* 5) This bone articulates with the nasal above and the maxilla behind; and, in the Mammals, provides the sockets for the incisor teeth. The two premaxillae in reaching upwards to meet the nasals (and in some forms, even the frontals) encircle the anterior opening of the nares and constitute the narial margins. The maxillae behind them are articulated by a suture at which the anterior margin of the maxilla tends to overlap the posterior margin of the premaxilla on the facial aspect of the skull. On the surface of the palate the maxilla and premaxilla articulate by a finely serrated edge to edge suture. In all mammals, before synostosis of the cranial bones has been completed, this palatal suture may be traced to the alveolar margin between the socket for the last member of the incisor series and the alveolus for the canine. From here in all mammals save man, the premaxillary-maxillary suture runs laterally to the facial aspect of the skull and becomes continuous with the overlapping suture between the maxilla and the premaxilla on the lateral surface of the upper jaw and thence passes upwards around the margins of the narial

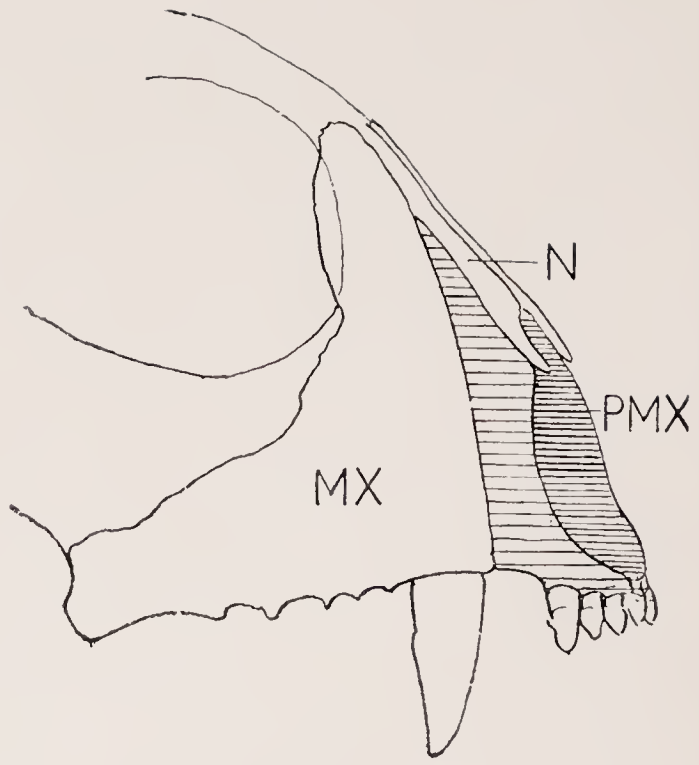

FIGURE 5

The condition of the maxilla and premaxilla in the typical mammalian upper jaw. MX = maxilla. PMX = premaxilla. N = nasal.

orifice. In man alone, the palatal suture, although very evident in youth and often persisting into comparatively advanced age, comes to an end on the alveolar margin and can be traced no further laterally than the mid point of the alveolar border between the lateral incisor and the canine. Only in Homo as a species is there no premaxillary-maxillary suture on the facial aspect of the skull at any time of life. The whole story of this peculiarly human distinction was made perfectly clear in readily accessible literature nearly a century ago; but even today there are those who regard this teaching as an unorthodox novelty, and, worse than that, there are those who, for lack of having conducted the simplest first-hand observation on appropriate material available to every anatomist, still maintain that in this regard man differs from the apes only in the time of closure of the facial maxillary-premaxillary suture. Wiedersheim in 1895 stated that " In man this fusion " (of the maxilla and premaxilla) " usually occurs soon after birth; in most apes, on the contrary, much later. In man the fusion first involves the facial portion of the bone." Such appears to be the belief still held by several modern writers on

comparative osteology who would seem to be unacquainted with Flower's standard work on the "Osteology of the Mammalia," published in 1870. Although 80 years ago Flower made the perfectly clear and correct statement that *in man "no trace of the maxillo-premaxillary suture is ever seen on the outside of the face"* there are those who apparently are still unaware of this simple fact. Flower's statement was based on the previous work of Callender (Phil. Trans. 1869. pp. 163-172) on "The Formation and Early Growth of the Bones of the Human Face." Briefly, Callender showed that in early embryonic life the human maxilla begins to overgrow the premaxilla at the overlapping suture line on the face. This overgrowth takes place by means of two main extensions of the maxilla (*see Figure* 6). The first is the *incisor process* ("Callender's maxillary clips") that grows forwards over the facial part of the premaxilla below the narial orifice. The second is the *nasal process* that, growing upwards and forwards over the premaxilla surrounding the narial margins, meets and tilts forwards the human nasal bones. This second process so completely covers and replaces the premaxilla on the face that in man alone the narial margins are constituted by the maxillae whereas in all other mammals they are made by the premaxillae. The part of the human premaxilla that was originally its facial process may be recognised for a short while in foetal life as a small flake of bone lying on the deep surface of the maxilla on the inner aspect of the lateral wall of the nasal chamber. The prominence of the human nasal bones and the projection forwards of the nasal chambers from the level of the face are specific features brought about by the development of the human nasal process of the maxilla overlying the premaxilla. The effects of the development of the human incisor process of the maxilla overlying the premaxilla are equally dramatic. In all mammals, save Man, the middle line suture that runs

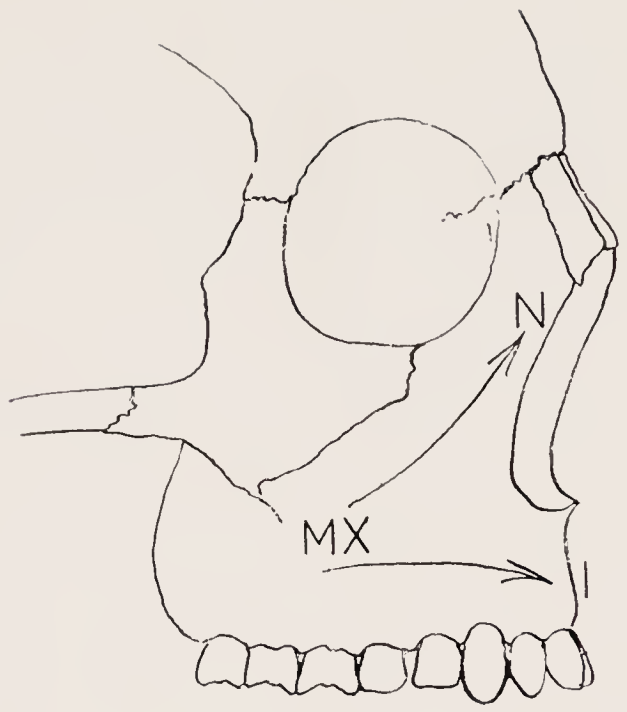

FIGURE 6

The bones of the human upper jaw. The maxilla has overgrown the premaxilla on the surface by N the nasal process & I the incisor process, thus excluding the premaxilla from the outer surface of the jaw and face. MX = maxilla with N the nasal & I the incisor processes.

from the lower margin of the narial aperture to the mid alveolar point between the two upper central incisors is an interpremaxillary suture; in Man it is an intermaxillary suture between the two overgrowing incisor processes. The covering over of the premaxillae by the incisor processes of the maxillae constitutes Callender's "maxillary clip": and the development of this clip brings about two essentially and specifically human characteristics.

In the first place, human orthognathism is undoubtedly associated with the developmental peculiarities of the human maxilla and in the second the paradoxical condition arises by which the human incisor sockets are formed on their labial aspect by maxilla and on their lingual aspect by premaxilla. We are now free to trace the limits of the premaxilla under the unique conditions prevailing in the human upper jaw. The edge to edge serrated suture between maxilla and premaxilla, which is conspicuous on the young human palate,

running from the nasopalatine foramen laterally to the alveolar border, can never be traced across the alveolar margin to its facial surface. From the point at which it is apparently lost on the alveolar margin between the lateral incisor and the canine, it may, however, be traced, in embryos of from 10 to 13 weeks, running from the anterior margin of the socket for the canine tooth, across the sockets for the two incisor teeth to the mid line incisive suture between the two premaxillae. This suture was appropriately distinguished as the "*interalveolar suture*" by Jarmer in 1922 (*see Figure* 7). Its presence shows conclusively that the sockets of the incisor teeth in Man are composed of the incisor process of the maxilla on their labial aspect and of premaxilla on their lingual aspect. In this regard Man differs from all other animals the incisor teeth of which are implanted wholly in the premaxilla. From the incisive intra-premaxillary suture the junction between the maxilla and premaxilla may be followed up into the nasal chamber where it delimits a small leaf-like flake of bone lying buried in the nasal chamber beneath the overgrown maxilla. The surface marking defining the posterior limits of this flake of bone passes downwards to the palate where it joins the palatal maxillary-premaxillary suture in the nasopalatine foramen.

It cannot be doubted that the peculiarly human development of the incisive processes of the maxillae and the typical human orthognathism are associated. Moreover, this human orthognathism is expressed far more in the form of the dental arcade than in its actual shortening. Much has been written concerning the shortening of the human jaw when comparison is made with the long-jawed "lower" mammals; but far more important than the actual shortening of the alveolar margin is the difference in form, whereby the human dental arcade is oval in outline, instead of being oblong.

Hunter made the shrewd observation that

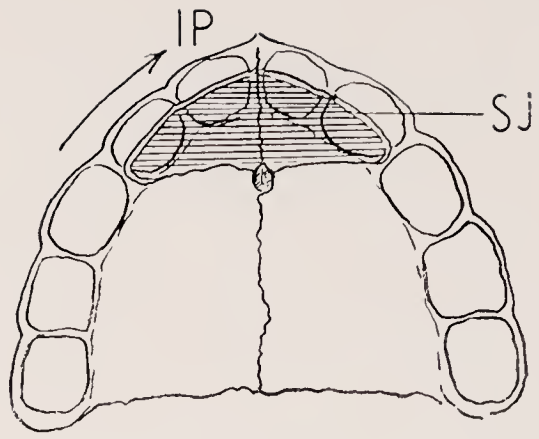

FIGURE 7

Diagram of the palate to show the limits of the human premaxilla. SJ = the intra-alveolar suture of Jarmer. IP = incisor process of maxilla.

teeth could be divided into three primary types: the dividers, the holders and the grinders and he noted that these three types of teeth were always placed in the same sequence in the jaw. "The dividers are always more external than the grinders." Such an arrangement appealed to Hunter as an example of the interdependence of structure and function; for the animal must of necessity have the teeth with which it obtains its food placed in front of those with which it chews it. There is no doubt as to the validity of Hunter's views regarding the functional reason for the change in form of the teeth from the front to the back of the jaw. But there is another, and a more mechanical, principle involved in this proximodistal transition of tooth form. It is obvious that teeth situated at the anterior extremity of the jaw and so placed farthest from the hinge, are, in the closing movements of the jaw, moved over a wide range with a minimum of force. Those placed nearest to the hinge will move over only a short range but they can exert the maximum crushing and grinding force. The transition from cutting incisors to grinding molars appears to be evidence not only of Hunter's functional principle but also (and in harmony with Hunter's concept) to express a very simple mechanical principle. Moreover, this transition is expressed not only in the form of the occlusal surface but in the rooting

of the tooth. The teeth near the hinge need firm implantation by multiple roots; those at the free extremity of the jaw are likely to have long single roots implanted so as to resist a simple thrust from the cutting occlusal edge. All three sorts of teeth, dividers, holders and grinders are needed by the young animal as well as by the fully grown adult. But as the jaw of the young animal grows longer in attaining its adult proportions, the relation of these teeth to the hinge of the jaw becomes altered. The whole set of "milk teeth" is ever growing further from the hinge. The grinders of the milk dentition, with their flattened grinding occlusal surface and multiple roots, are now situated too far in advance of the hinge for proper functioning. Other molar teeth (of the so-called "permanent" dentition) are erupted behind them, nearer to the hinge. But in the end the "milk molars" must be shed and then they are replaced by teeth which are neither true grinders nor true dividers but, occupying an intermediate position between the hinge and the free extremity of the jaw, make approaches to the occlusal pattern and rooting of the teeth in front of and behind them. The eruption of molar teeth might almost be regarded as a continuous sequence conditional upon the lengthening of the jaw with growth and so with the relation of the grinders to the hinge of the jaw. But this continuous sequence must be broken when the two "milk molars" are displaced forwards from the hinge until they come into the region in which force is not so great, but movement is carried out over a wider range. When this happens they are shed and replaced by teeth of a (varying) intermediate form between cutters and grinders. This is a process that takes place in all diphyodout mammals and the degree of lengthening of the jaw from birth to adult life appears to determine the number and character of the replacing teeth. In the so-called "lower" mammals in which the jaws are notably prolonged in adult life the differentiation of the various types of teeth, incisors, canines, premolars and molars is well marked, both by the progressive changes in occlusal pattern and in root formation from the front to the back of the elongated jaws.

Now it is to be noticed that in Man the shape of the dental arch differs from that of the most advanced "lower" mammals in that it is of a curved oval form instead of being a rectangular oblong. From a mechanical point of view, this may be expressed by saying that in Man the whole dental arcade tends to be more uniform in its relation to the hinge than does the elongated oblong arcade of the "lower" mammals. We would therefore expect that in the human dentition there would be more uniformity and a steadier gradation in the transition from cutter to grinder than would be found in a long-jawed animal. This is, of course, the outstanding peculiarity of the human dentition. In the oval dental arcade of Man there is no sudden break. Single rooted incisors and canines pass to (typically) single rooted premolars and so to multiple rooted molars. Man possesses a graded series of teeth that, regarded either from the point of view of their occlusal pattern or of their rooting, constitute a transition from cutting incisor to grinding molar in a series embraced in a comparatively short oval dental arcade.

DISCUSSION

The President, in proposing a vote of thanks to Professor Wood Jones for his instructive and entertaining Lecture, said that he had been prepared for lucidity of expression and clarity of thought in a Lecture by Professor Wood Jones but he had not been altogether prepared for his capacity for recreating a sort of excitement of discovery. He had felt during the Lecture as if he were accompanying Professor Wood Jones in the process of discovering the wonderful developments which had led to the present human jaw. When the Lecture appeared in print he would read it with very great interest and would be able to study it with a much more critical judgment than he had been able to exercise in listening to it that evening.

The vote of thanks was accorded with acclamation, and the meeting then terminated.

The Design and Behaviour of Orthodontic Springs

by Mr. Norman Wild, m.sc., l.d.s., v.u. manc.

Mr. President, Ladies and Gentlemen, it is indeed an honour that has been conferred upon me in my being asked to read a paper before this Society. I trust that the contents of this contribution, whilst being mainly of academic interest, will, nevertheless be of sufficient value to be a help in the understanding of the "Behaviour of Orthodontic Springs."

It is with some diffidence that I give this paper to you tonight, and I do so only after having first been assured by various members of your council that in it you will find something that is worth while.

One fully appreciates that the mechanical procedures employed in the treatment of malocclusion are but a very small part of the huge field which is orthodontics. Thus, I am neither suggesting to you any specific line of treatment, nor am I applying greater emphasis to mechanical cures than to the fundamentals of growth and development, aetiology and diagnosis. I am merely trying from a point of interest to show, since of a necessity we must all be engineers in greater or lesser degree, how springs behave when subjected to various loads which we apply through them to the teeth in mechanical therapy.

We are all familiar, I am sure, with those splendid papers which our President presented to this Society, published in the Dental Record in 1924. But, one feels, if I may say so, sir, that the approach made to this subject was more in the nature of a mathematical approach and should be extended so that the actual working of the spring could be demonstrated. With this in mind, and using our President's work as a foundation, I devised three types of apparatus which I will eventually describe to you. The first two types I must describe only briefly because of lack of time.

It is known that the physiological reactions of the bony tissues to a steady force deliberately applied to a tooth, if this force be non-traumatic, are such that the tooth will move in the direction of that applied force. It was considered possible, therefore, to reproduce experimentally orthodontic tooth movements similar to those seen in the mouth which are the result of modifications in the bony tissues.

Bone can be considered as a plastic medium encasing the root or roots of the teeth. Pitch forms a striking analogy. On a cursory examination a block of pitch appears to be hard and resistant to deformation, but actually the material is highly viscous and can readily change its shape under a steadily applied load. In other words, pitch can "flow" under a sustained load. For example, if soft pitch is cast around a slender vertical body, such as a walking stick, and allowed to solidify, it can be shown that the viscosity of the solid pitch permits the stick to move if it is subjected to steady pressure.

It was felt, therefore, that pitch or a similar viscous substance could be used as a substitute for bone as the embedding medium in studying the effect of orthodontic springs in tooth movement.

Pitch was not however, considered to be

Paper presented to the meeting on 11th December.

an ideal material since its physical properties are variable, so as an alternative a good make of sealing wax was employed.

APPARATUS I

An apparatus was devised consisting of an open copper box, (Fig. 1). This was placed inside another box and two holes were made below the strengthening rims of the boxes. These holes carried a tube, D, housing the shaft of an Ames' dial which was incorporated in the apparatus and whereby tooth movement could be registered. The inner box was filled with paraffin to the level of the wax. The paraffin, when heated by two electrical resistances coupled in series which were incorporated in the apparatus, served as a heating medium for softening the wax.

The test spring was supported by a chuck suspended outside the copper box, thus making it independent of dimensional changes in the box due to thermal expansion. The chuck was arranged in such a manner that it could be raised and lowered, thereby placing the spring in any position.

The whole of the apparatus was put into a heat insulated box, a thermometer being inserted through the roof in order that temperature readings could be taken whilst experiments were in progress. The pressure was transmitted through a small hole in the side of the insulated box to the Ames' dial fixed on an outside platform.

The test tooth was placed into the wax and the required amount of pressure was applied to the spring by means of a small apparatus graduated from 0 to 150 grms. and known as a "pressure applicator." In all, nine springs were tested with this apparatus, all being of the same diameter, 0.35 mm. Three tests only will be described.

Fig. 2 shows an experiment to be carried out using a simple modified cantilever type spring. The dimensions of the spring can be seen in the diagram, and it will be noted that the rate of movement of the test tooth was found to be steady for a period of

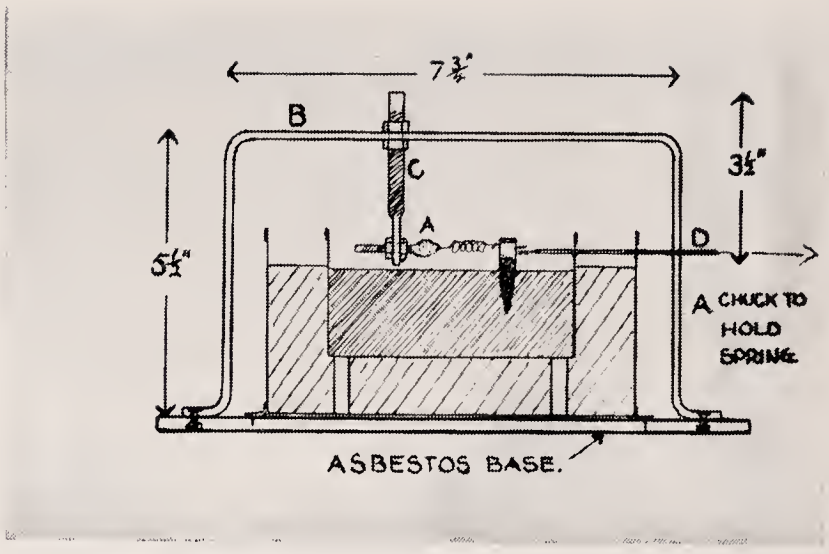

FIGURE 1.

approximately 40 minutes. Thereafter the rate was decreased until at 80 minutes the recorded movement became very small. Up to 40 minutes, the movement averaged 2/100″ in 10 minutes, falling to half this value after 80 minutes. The curve appeared to be nearly horizontal at the end of two hours, showing that the resistance of the wax was sufficient to balance any remaining pressure stored in the spring.

A further test was made using a spring of the same design as the previous one except that a further coil was inserted at the point of fixation. It was seen that the performance of this spring was similar to that of the proceeding one. Movement began to decrease after about 40 minutes, after which the tooth moved at a diminishing rate until a state of equilibrium had been reached between the pressure of the spring and the resistance of the wax. It is probable that the increase of the effective length of the spring caused by the introduction of the second coil, was so small that the apparatus was insufficiently sensitive to register any alteration in the rate of movement.

Another spring was tested in which the second coil was inserted 0″ from the point of fixation. As would be expected, the amount of movement of this spring for the same time of application was less than in the case of the previous spring owing to a greater degree of elasticity. The curve of this movement was also less pronounced, showing that a greater degree of travel can

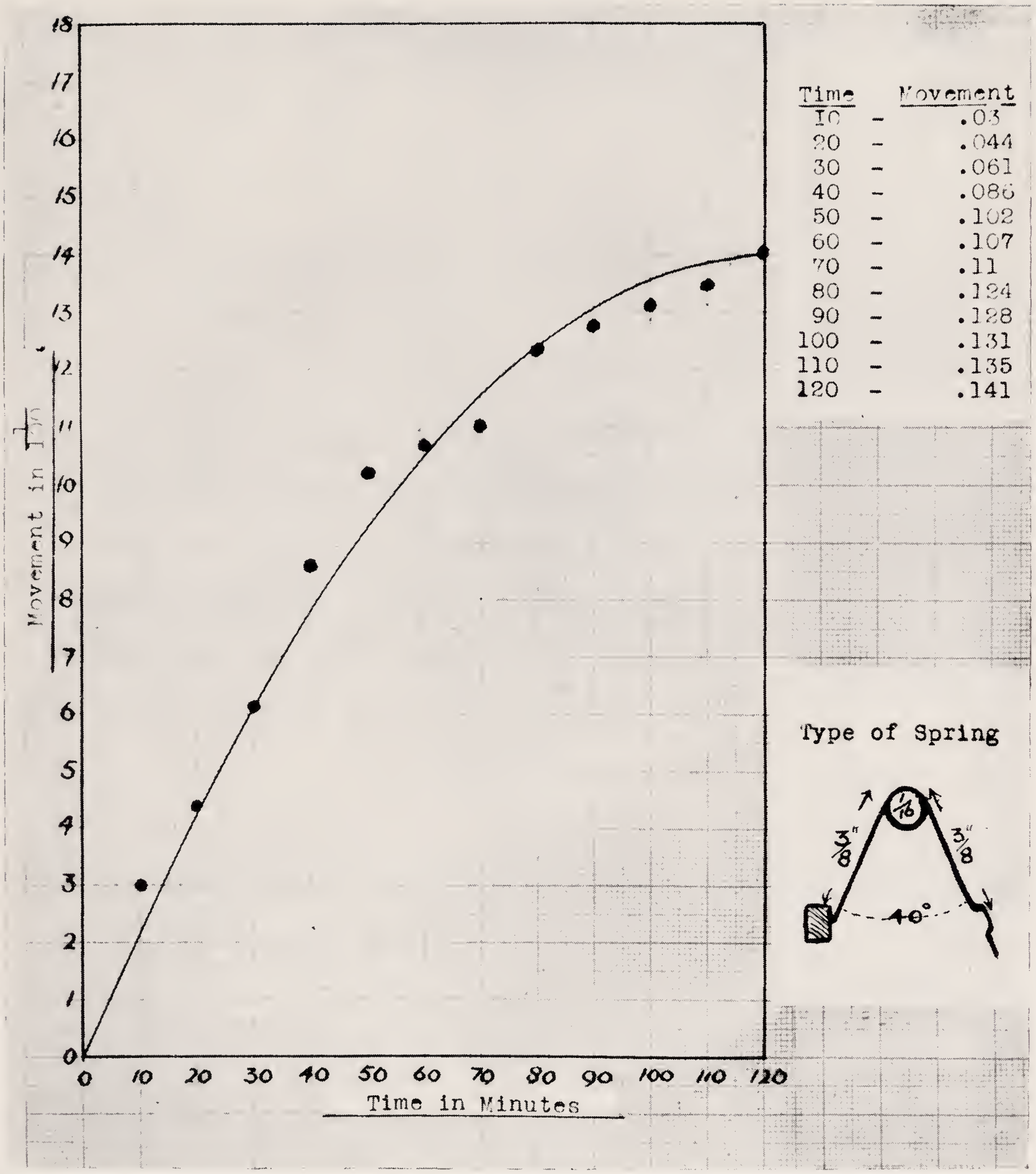

FIGURE 2.

be expected from the test tooth than was observed with the previous spring before the state of equilibrium with the wax was reached.

Repeat tests were carried out on a few of the springs, the time of testing being increased to 12 hours, readings being taken every hour. It was seen that the amount of travel of the test tooth up to a period of two hours was similar to that observed in the first experiment. Thereafter, the rate of travel began to diminish, until after four hours only slight movement was registered.

The conclusions resulting from these tests show that a spring, irrespective of the design, exerts a force that is equal to that of a load which is applied. The amount

of compression in a less elastic spring is not so great as that exhibited by a spring of a more elastic type, therefore the amount of movement of a tooth is in proportion to the elasticity of a spring.

Apparatus II

The apparatus just described was designed to demonstrate the behaviour of a tooth embedded in sealing wax when subjected to a known load. A further set of experiments was carried out to determine the amount of compression of a spring to which was applied a known load.

This apparatus consisted in effect of a simple tensometer. A horizontal bar supported by two vertical rods, carried a chuck which held the spring to be tested. A stirrup pan constructed in methyl methacrylate resin, was so arranged that it could be used to carry the weights by which the spring was loaded.

Adjacent to the stirrup pan was a vertical rod carrying a horizontal bar pivoted on a knife edge. The horizontal bar carried a pointer so arranged to engage the base of a stirrup pan.

The principle of the working of the apparatus is shown diagramatically in Fig. 3. At a distance of 1 metre a celluloid scale was erected vertically. Placed upright on the horizontal bar and at right angles to it was a mirror on to which was focused a beam of light. This beam being reflected back to the scale. Thereby, any movement of the loaded pan (i.e. the amount of compression of the test spring) was shown in an enlarged reading. The weight of the stirrup, 5.95 grms. being a constant, was not considered in the tests.

Fig. 4. shows the deflection obtained when a simple recurved spring was used. It was noted that little appreciable difference is seen by inserting a coil at the point of fixation of the spring. When the coil is arranged a distance from the point of fixation, greater compression results for the same load. It was noted later that when tests are made with enlarged springs, insertion of a coil at the point of fixation is of significance. The apparatus used in these tests was no doubt insufficiently

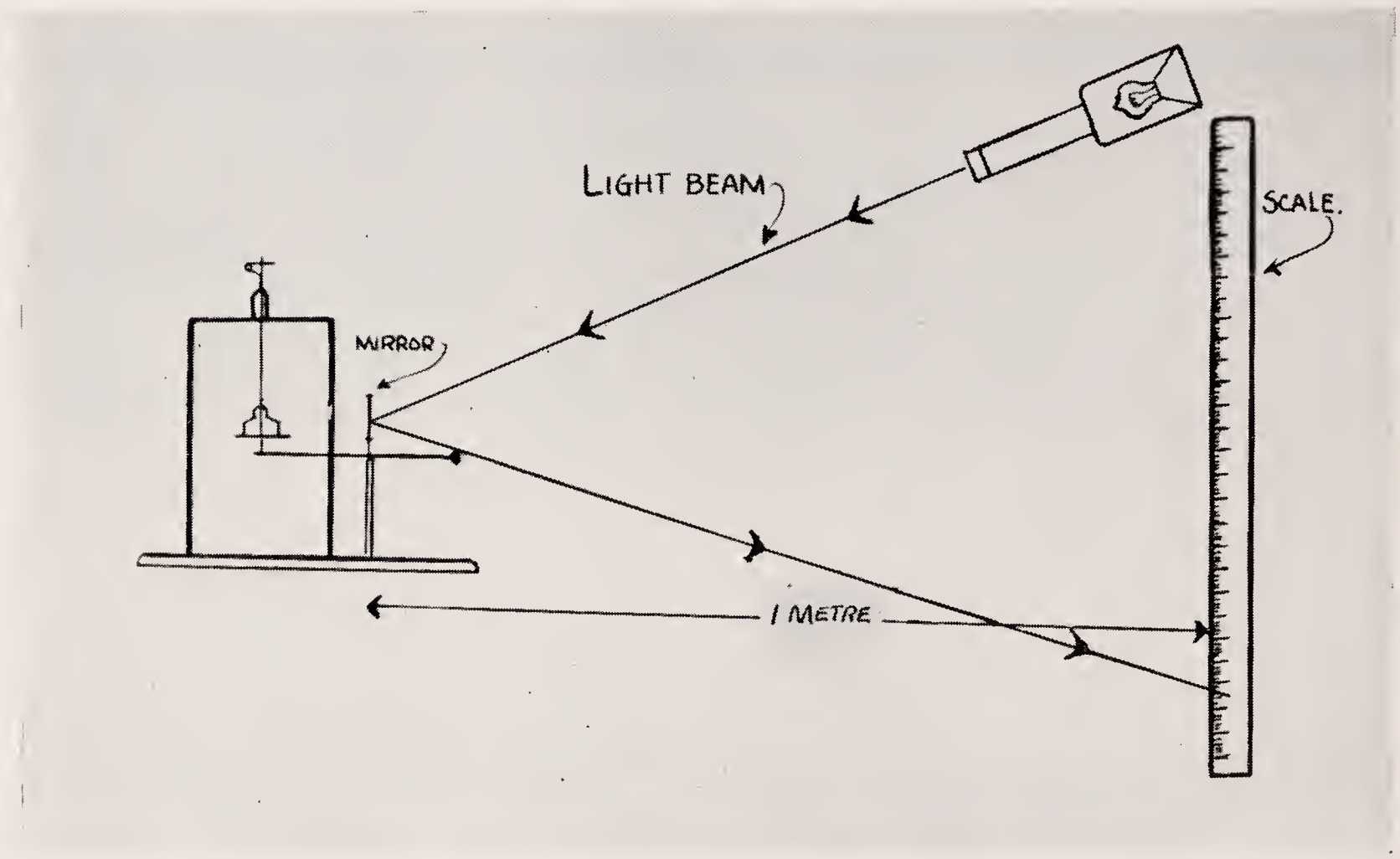

FIGURE 3.

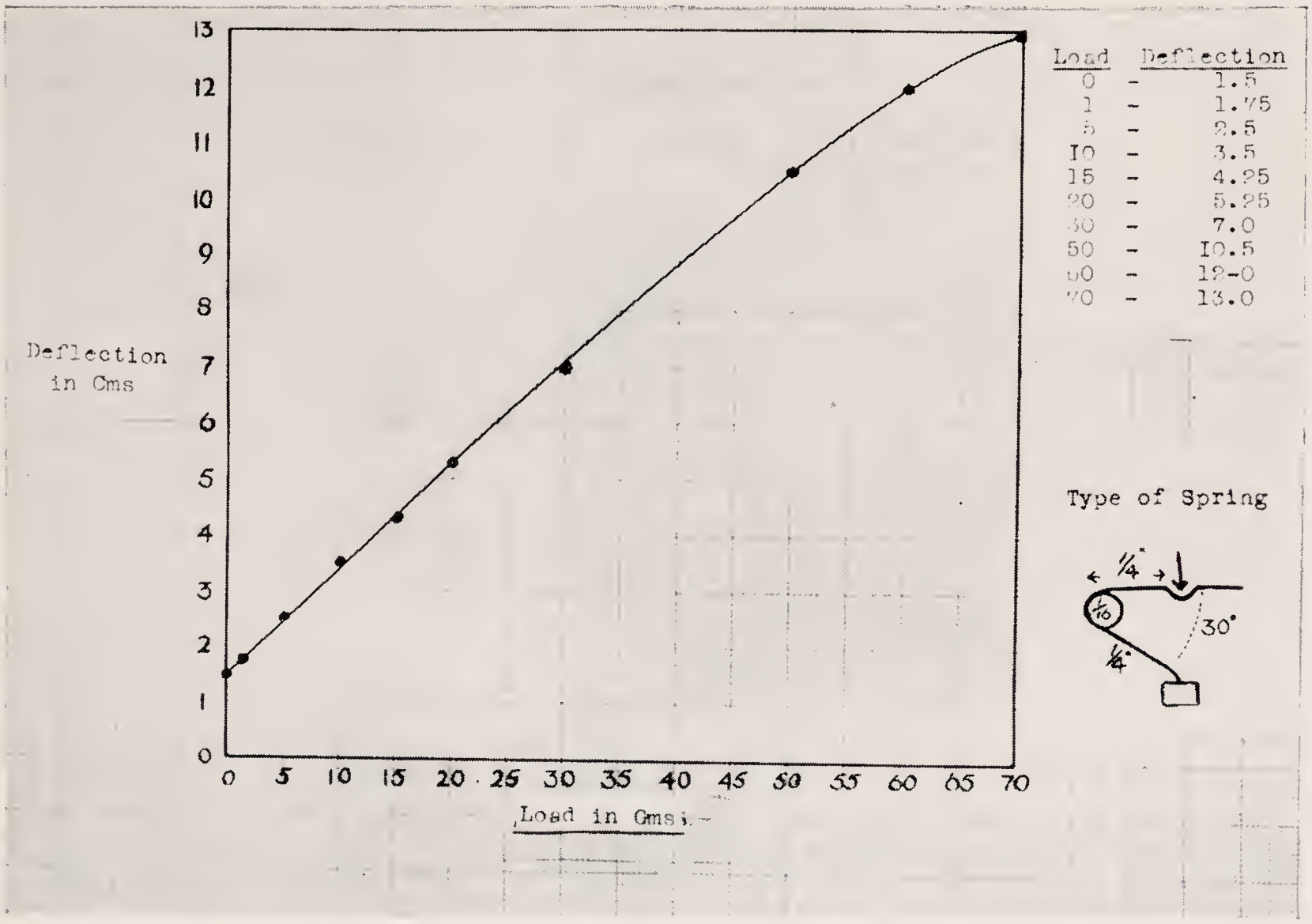

FIGURE 4.

sensitive to record any difference made by a coil inserted in this position.

Similar tests were made with springs containing coils of greater or lesser degrees, and the results were comparable to those which have been shown. It was felt that no accurate conclusions could be drawn from these tests owing to the difficulty of precisely loading springs of such small dimensions. It appears that the insertion of a coil at the point of fixation of the spring has no practical value, but the general inference is that by the introduction of one or more coils of varying diameters at points in the spring other than the point of fixation, the effective length is increased. In consequence the compressability of the spring becomes greater.

Apparatus III.

It has been shown in experiments with Apparatus I. that irrespective of the type of spring used, tooth movement is always equal to the amount of compression of the spring. In tests with the second apparatus, the "stress strain" curves obtained were similar in form to those previously discussed, the small variations which occurred being due to the practical difficulties of loading springs made on so small a scale.

A further set of tests was carried out to investigate the behaviour of simple springs when subjected to various loads, and to ascertain the position on the springs where the load must be applied, in order to make the most efficient use of its elastic properties.

An apparatus was therefore devised to enable readings to be made from springs of ten times the normal size, taking as an average size a spring of length 1.0 cm. and diameter 0.35 mm. But in the consideration of the enlarged spring the diameter of the wire would not be increased in proportion to its length since the modulus of bending of a beam and the modulus of section of a beam have to be considered. Taking the formulae of these two moduli, Dr. K. M. Entwistle of the University of

Manchester derives the expression

$$R = 4\sqrt{\frac{L^3}{l^3}} \times r.$$

=distance from point of fixation to centre of curvature of bend of small spring.
L=distance from point of fixation to centre of curvature of bend of large spring.
r=radius of cross section of small spring.
R=the unknown dimension of radius of cross section of large spring.
Resulting from the above expression it was seen that the diameter of the wire to be used was 1.9 mm.

Fig. 5. shows the apparatus employed in the tests. It consisted of a vertical board, B, suitably strengthened to prevent warping and fixed to a wooden base which could be levelled by screws, S and S_1, placed at its four corners. Attached to the board, B, and running vertically were two metal guides M and M_1, arranged in this manner in order that a piece of standard size graph paper could be held in position. A steel rod X, was fixed to the base near to the vertical board with the aid of two clamps, C and C_1. Another steel rod, Y, was attached to the rod X by two pieces of metal. The manner of its attachment was such that it could be made to slide backwards and forwards along the rod. A metal chuck, H, was clamped to the rod Y, by a block and screw, thus facilitating either an upwards or a downwards movement. The enlarged spring was fixed in the chuck and a shadow of its movement resulting from loading was obtained on the graph paper by focusing a beam of light from a point approximately 23 inches away from the paper. The shadow was then traced on the graph paper with pencil and later drawn in with ink.

To ensure accuracy, the spring coils were made by bending the wire around steel formers of the appropriate diameter. An allowance had to be made to compensate for the elastic recovery in winding the coils, the "former" diameter being

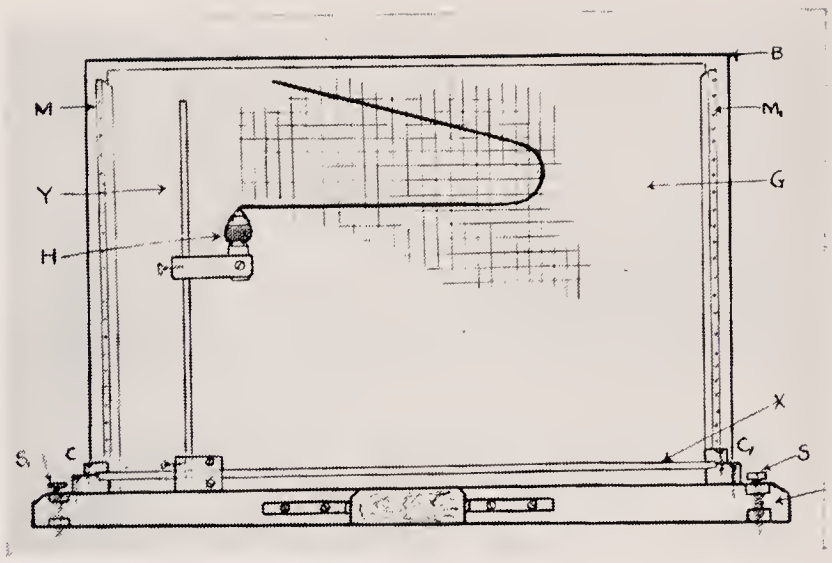

FIGURE 5.

less than the final coil diameter.

Experiments were primarily made with a simple spring of the cantilever type fixed at one end (Fig. 6). The applied loads were 4 ozs., 8 ozs., and 12 ozs., and the amounts of deflections of the spring under these loads were noted.

Fig. 7 shows a test made with a simple cantilever spring of the same length to which has been introduced a coil of $\frac{5}{8}$" inside diameter near to the point of its fixation. Readings were taken applying the same loads as with the previous spring and the incremental deflection was now found to be doubled.

Fig. 8. shows the results of these tests carried out with a spring similar to the one described in the first test, but of greater length. The length of spring required to give deflections similar to the spring in Fig. 7 was determined. To obtain the same amount of movement the length had to be increased to 15.75 cm. In the absence of the coil it is thus necessary to increase the length of the spring by approximately 50%.

A further series of tests was carried out on a spring of the anatilever type (Fig.9) but recurved upon itself giving two parallel levers AB and CD and according to McKeag, acting as two independent springs. That is AB is fixed at B, and CD at D, AB counterbalancing the movement at CD and thus causing any teeth to which the force of the spring be applied to move

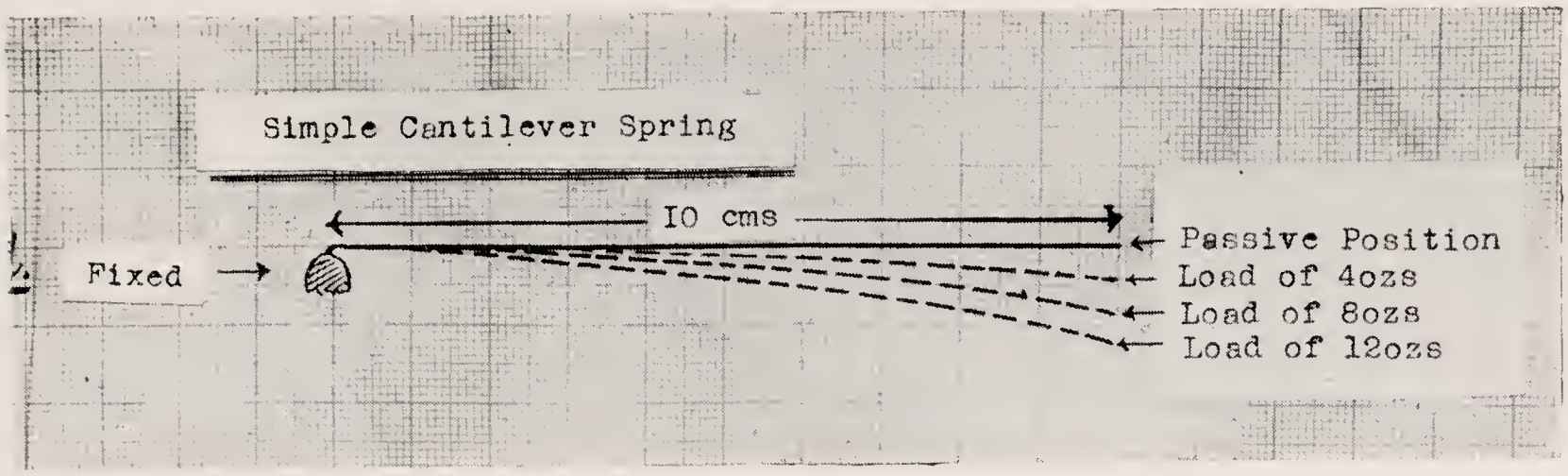

FIGURE 6.

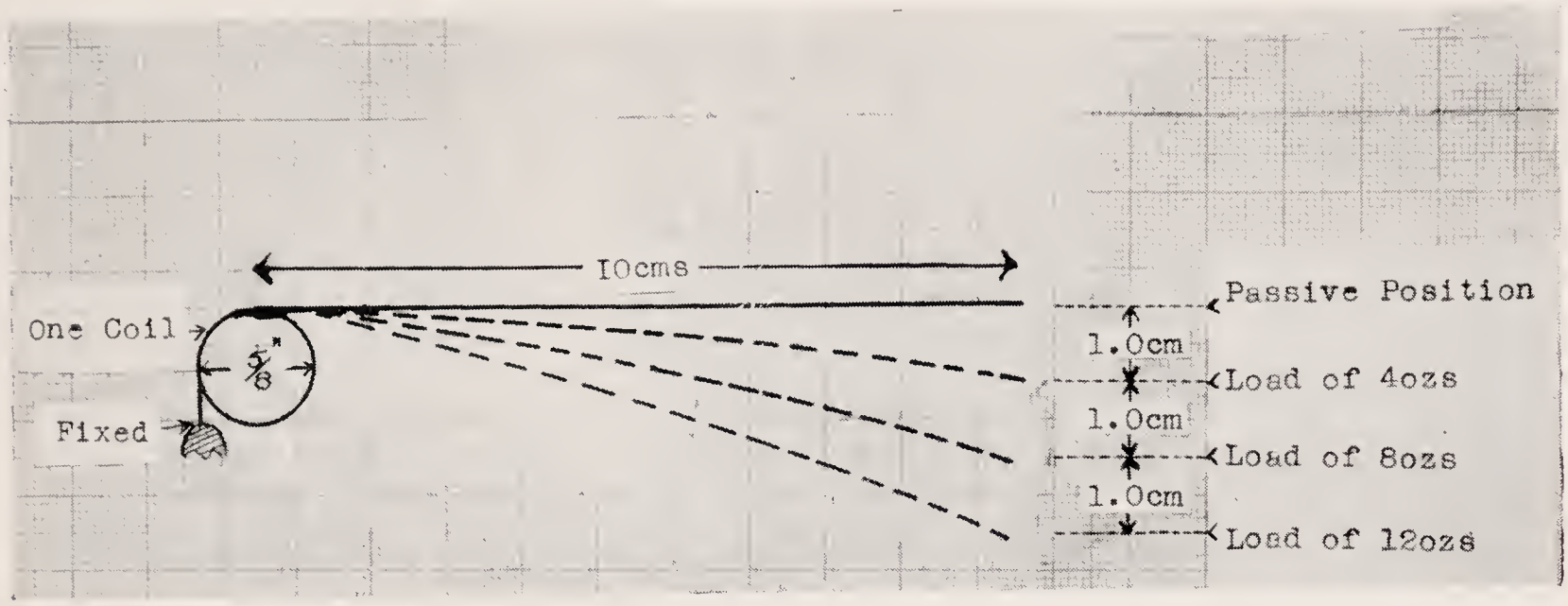

FIGURE 7.

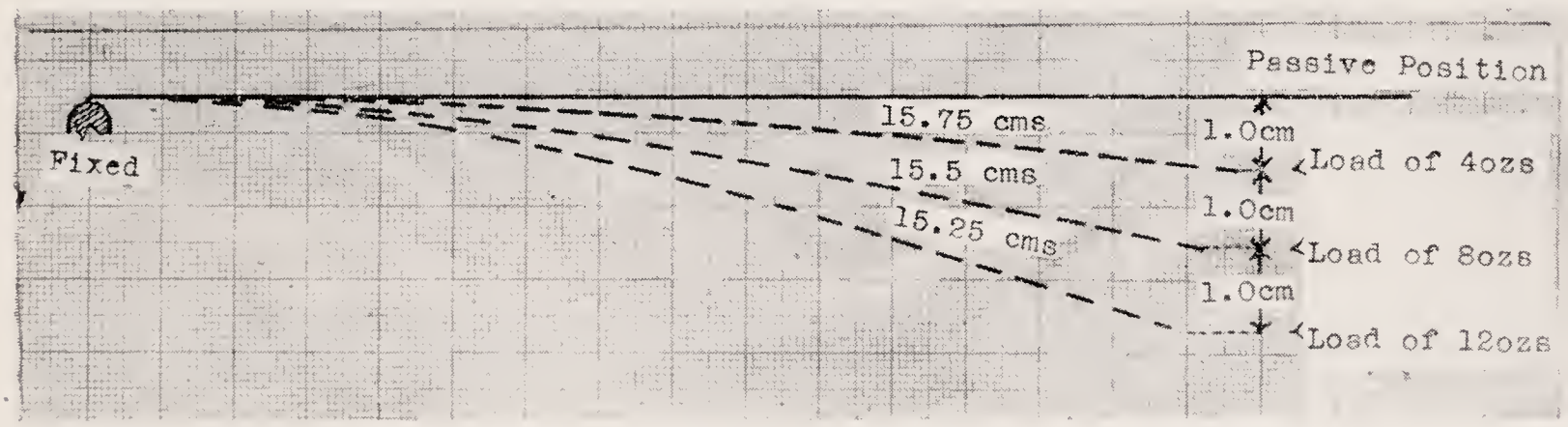

FIGURE 8.

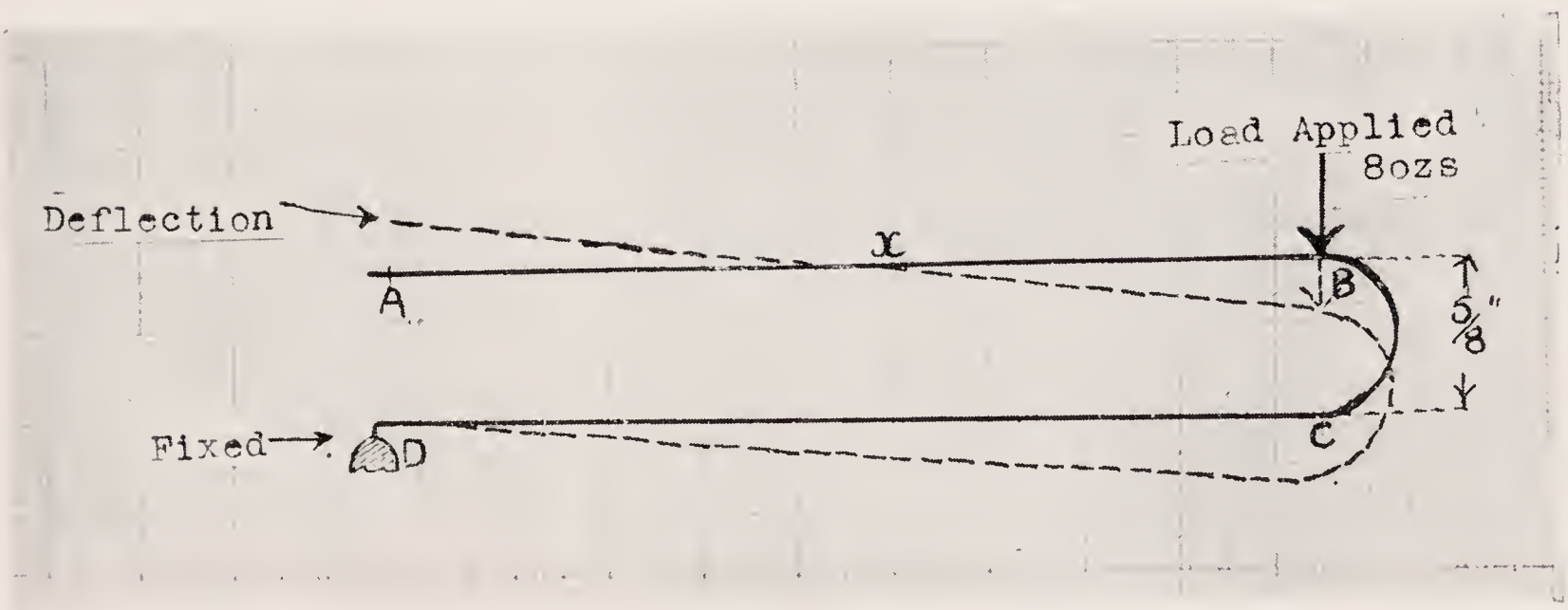

FIGURE 9.

in a plane parallel to AB. Before making any tests on this spring a few initial empirical tests were made using finger pressure on conjunction with a simple apparatus. It could be felt that a greater digital pressure was required at the fixed end of the upper part of the spring to keep it horizontal. This contradicts the postulate that the spring acts as two independent springs, each counterbalancing the other. It was therefore decided that a more accurate investigation on the behaviour of this spring must be made.

A test was made with the spring seen in Fig. 9 on which a load of 8 ozs., was applied at point B, and it was noted that this caused an equal movement at that point and at point C. There was an elevation of the free end A, to an extent approximately equal to the depression at B and C. In Fig. 10 is shown the result of applying loads of 8 ozs., at A and B respectively. The amount of depression at A was approximately twice that at B, i.e., there was a greater resistance to the load at B than at A.

Further tests were made with this same spring, Fig. 11 to determine the load which would have to be applied at B, to move this point by an amount equal to the

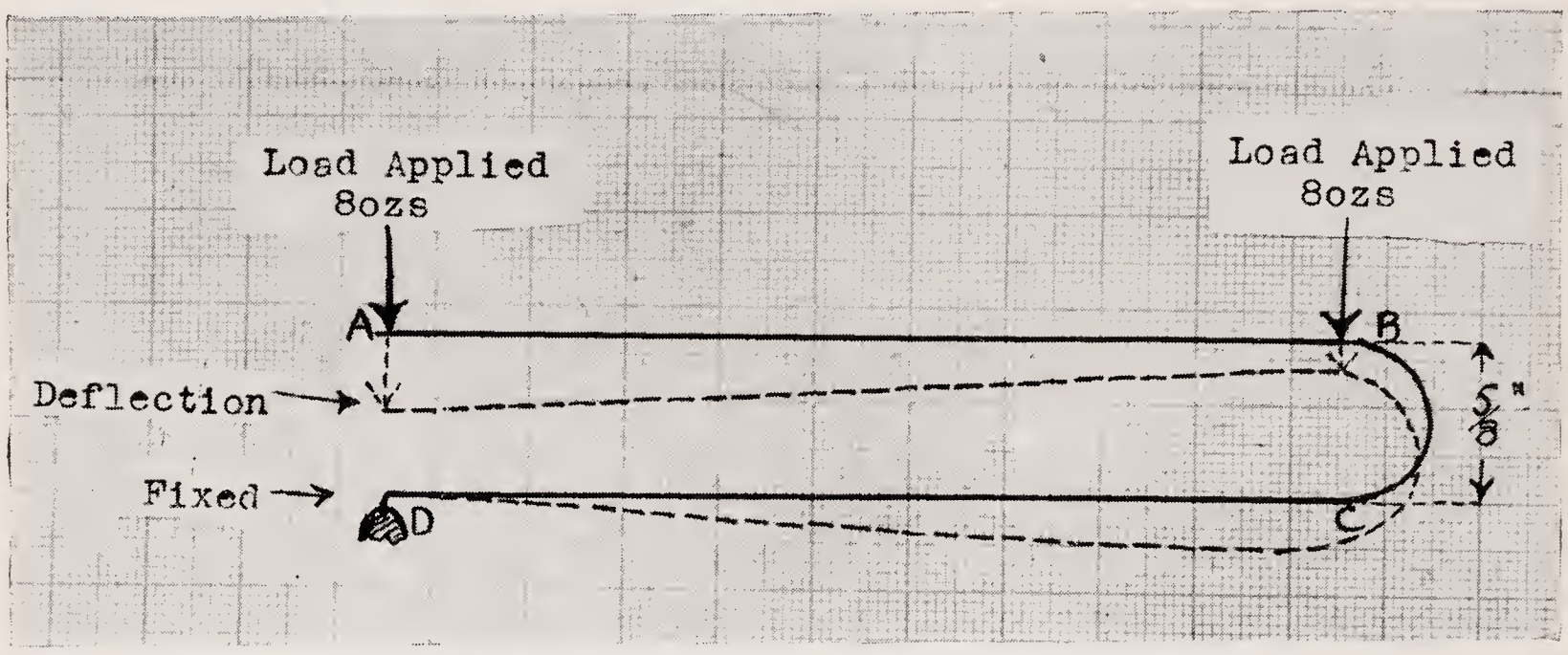

FIGURE 10.

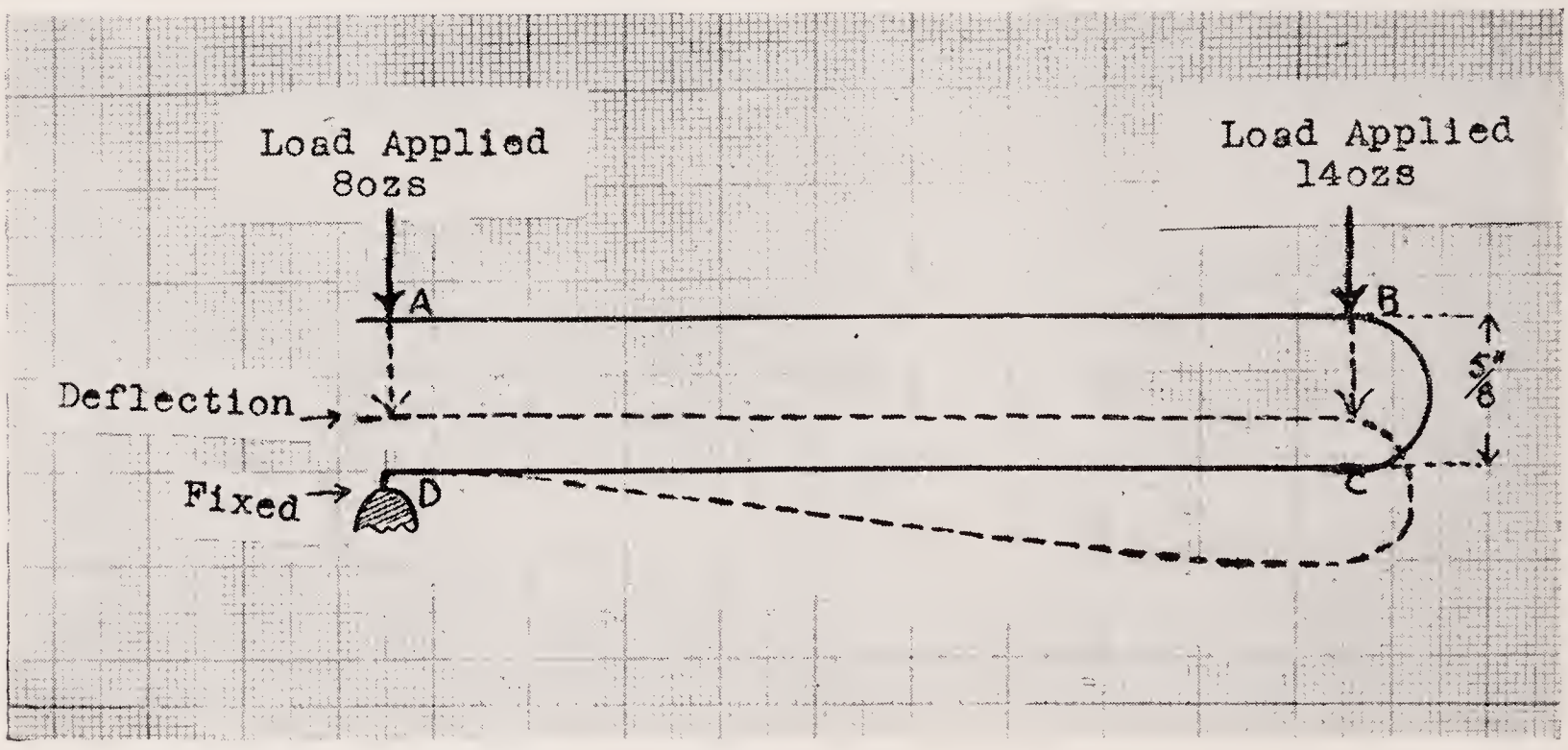

FIGURE 11.

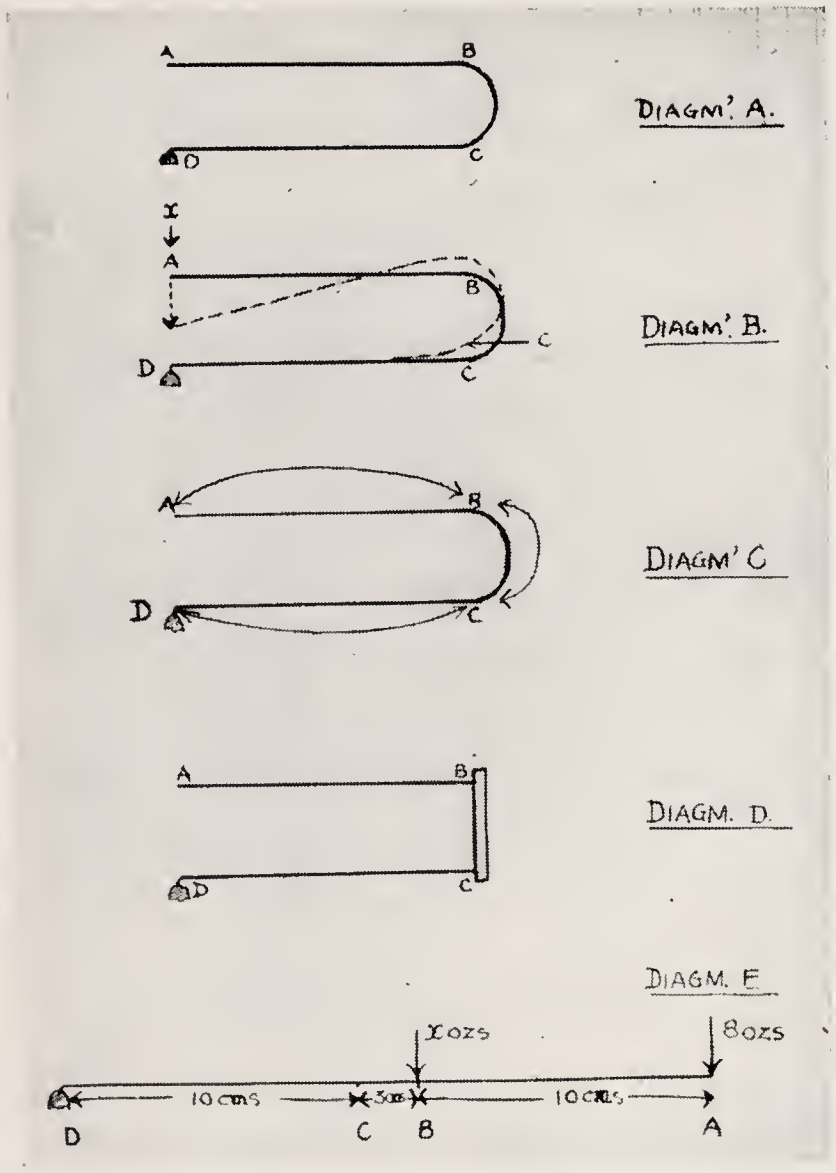

FIGURE 12.

movement at A, i.e., to keep AB horizontal. A load of 14 ozs., at B was necessary to compensate a load of 8 ozs. at A.

In another test a load of 14 ozs. was applied at C, instead of B, and as previously the load of 8 ozs. was applied at A. The behaviour of the spring was now exactly similar to that of the spring shown in Fig. 11.

It can be shown (Fig. 12) that when a load x is applied to the recurved spring a A, (Diagrams A and B), displacement is similar to that of a cantilever spring of length DC, CB, BA, fixed at D. The movement from C to C_1 is equal to that at the approximate mid-point of a straight spring A-D. The upward displacement of C is due to the sharing of the load by AB and DC and the resulting elastic bending of DC.

It is seen that a much greater load is required at B than at A to move both these points an equal distance. To explain this, the spring must be considered in these parts, namely, AB, BC, CD, (Fig. 12 Diagram C). Since it would require a much greater load than is used to bend BC, it can be assumed that although the load is applied at B, it is acting through C. Hence for all practical purposes we have two rods fixed at D and joined at BC by a rigid vertical bar (Fig. 12 Diagram D). The weight of the load at B or C, appears to be great when compared with that at A, (i.e. A—8 ozs. and B or C—14 ozs.). But if moments are taken about a bar of 23 cms. in length (the curvature of the semicircle at BC equals 3 cms.) then it is seen mathematically that the load of 14 ozs. is the correct load for such a spring (Fig. 12, Diagram E).—

Moment of A = 8 (load) $\times$ 23 (length of cantilever) = 184

Moment of B = $x \times 13$

$= 13x$

$13x = 184$

$x = 184$

$\overline{13}$

$x = 14\,2/13$ ozs.

To keep AB horizontal (Diagram B) when a load x is applied to A, a load of approximately $1.5x$ must be applied to B. The variation in the load along the length of the free arm of the spring which is necessary to cause a parallel displacement of that arm, therefore, makes this spring unsuitable for orthodontic purposes. As has been claimed, this type of recurved spring certainly functions mainly as two similar independent springs but no practical advantage accrues from this consideration for the reasons stated. It is necessary to incorporate one or more coils in the spring, as will be shown later, in order to endow it with characteristics demanded in an orthodontic spring.

It can be seen that by the introduction of coils at either or both the point of fixation and between B and C on the recurved spring, the behaviour alters very

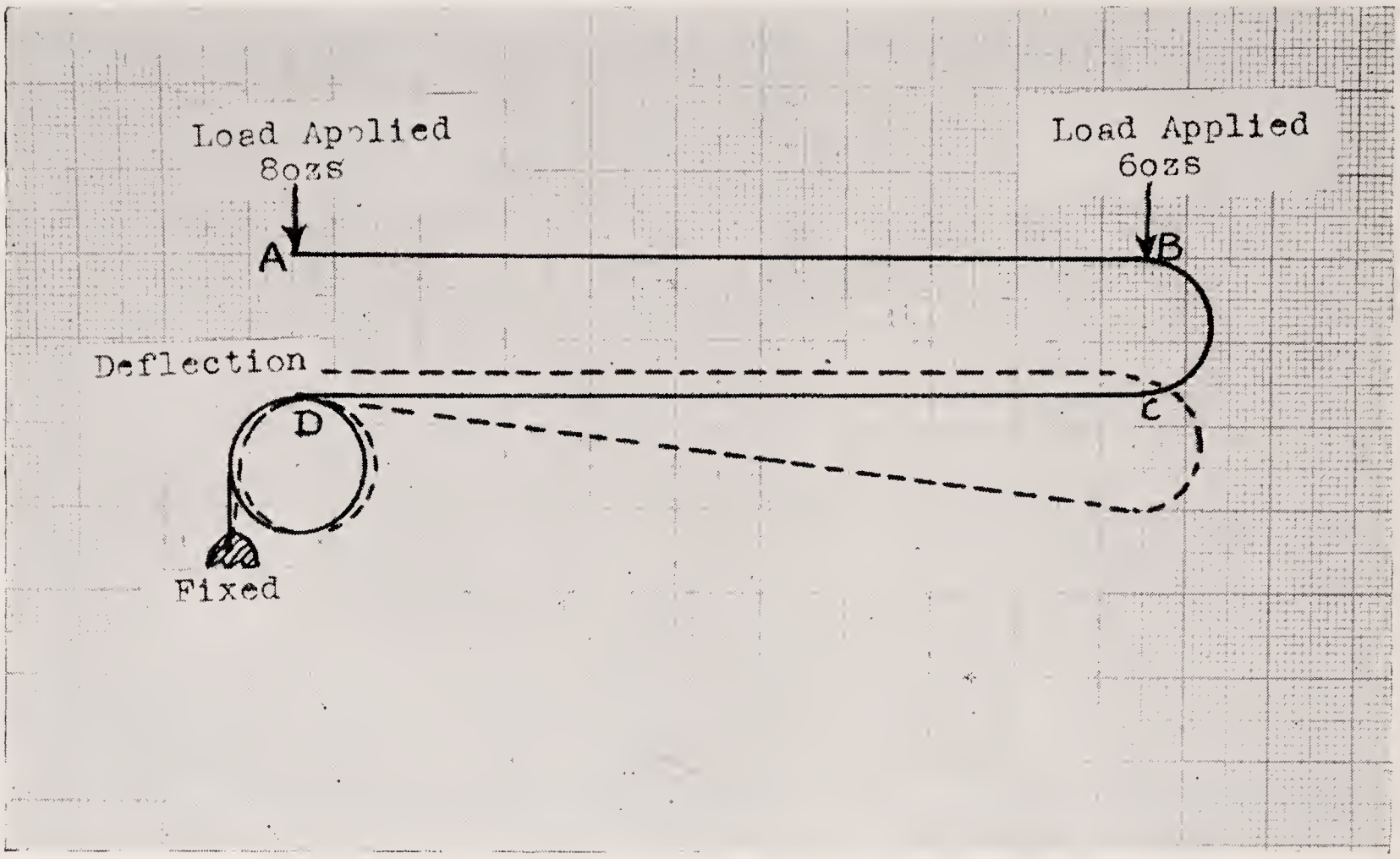

FIGURE 13.

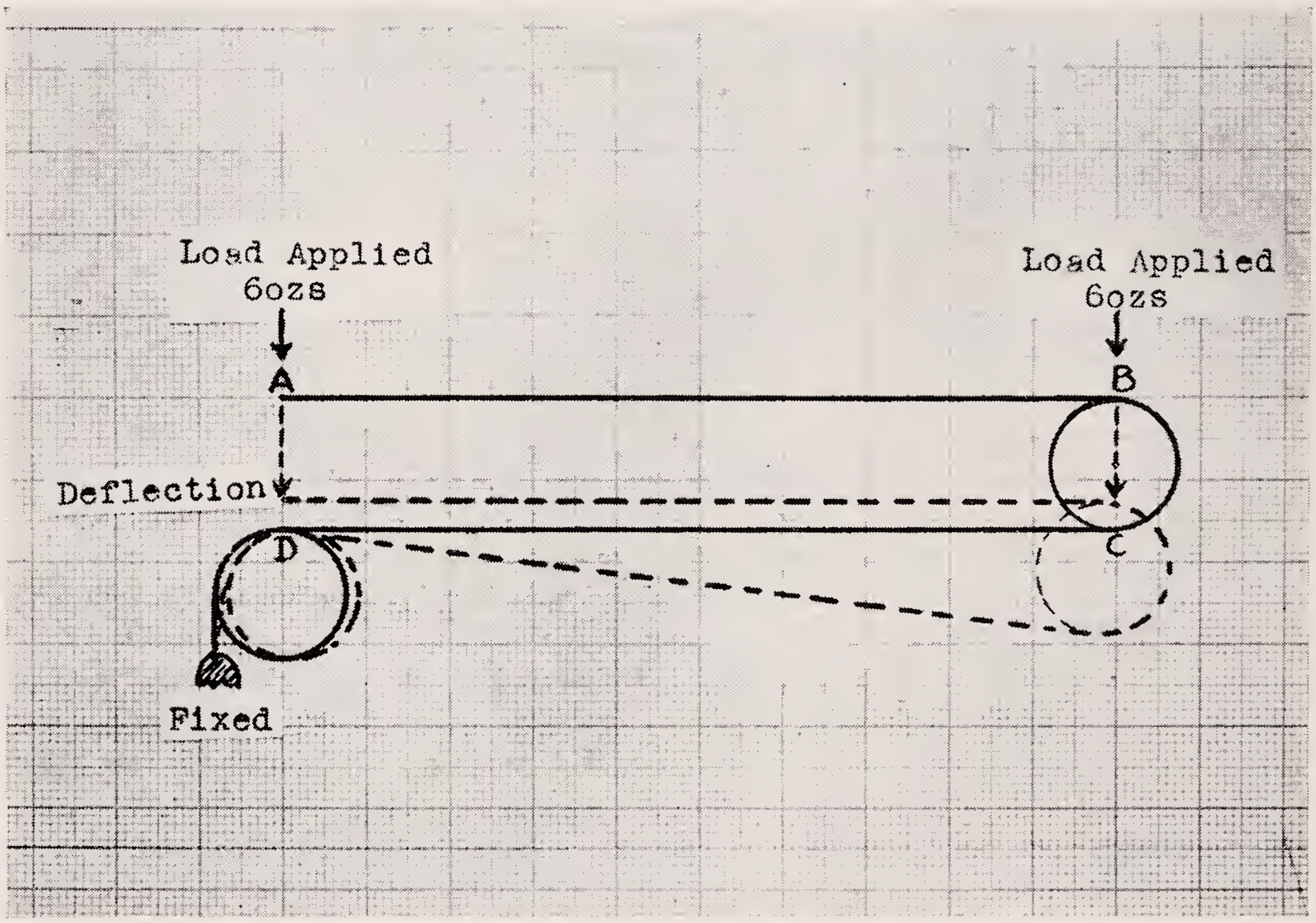

FIGURE 14.

considerably. This is no doubt because the spring ceases to function as a single spring AB, BC, CD, but is now split up by the coils into separate springs each of which acts independently and also there is again an elasticity from both of the two springs. This was shown to a marked degree by the introduction of a coil at D (Fig. 13.)

In previous tests with this type of spring when fixed at D without the coil, it was seen that a greater load was needed at B (or C) than at A in order to keep the arm AB horizontal. By the introduction of a coil of $\frac{5}{8}''$ inside diameter at D, the load at B (or C) is now less than that required at A to keep AB horizontal. Thus the introduction of this coil at D increases the effective length of CD and makes the spring appear as if the arm CD were extended in the direction of D. On the other hand it can be shown that if the loads be equal on this spring, the length of the arm AB would have to be extended in the direction of A.

If two coils are introduced into this spring, one at BC and one at D, the point of fixation, the behaviour is completely altered (Fig. 14). The spring now acts as two separate elements, AB fixed somewhere at BC and CD fixed at D. If the coils be equal then AB can be made to travel in a horizontal direction by the application of equal loads at A and B. Thus the postulate that a recurve cantilever spring acts as two separate springs appears only to be true if coils be introduced at the points indicated.

I would here state my appreciation for the help and encouragement given to me by Professor Matthews of the Department of Prosthetics, Professor Thompson of the Department of Metallurgy and Professor Wilkinson, formerly of the University of Manchester.

DISCUSSION

THE PRESIDENT said he was sure that everyone present had enjoyed listening to the paper. He himself had found it specially interesting, because in one sense it was founded on a contribution which he had made to the Society a good many years ago. In view of the number of years which had elapsed since then, he was not unduly perturbed to discover that some of the conclusions at which he had arrived on theoretical grounds were not valid when the subject was examined experimentally.

When he had begun to investigate the subject he had found that the people who had explored it previously were engineers concerned with building operations and with structural stresses, and on tracing back the history of their scientific approach to the subject he had found that the science had been founded by Galileo. In spite of his reputation as the founder of the experimental method, Galileo had approached the subject not from the experimental point of view but from the mathematical point of view, with the result that his early pronouncements on the stresses of beams proved to be misleading.

It appeared that he himself had also come to wrong conclusions through approaching the subject of orthodontic springs from the theoretical point of view without checking the theoretical results by experiments with the springs. As a matter of practice, his experience was that the value of the coils was as a safeguard against traumatic stresses, which would damage the springs, rather than as contributing to the pressure behaviour of the springs in the movement of teeth. He would study with great interest the actual behaviour of the springs when Mr. Wild's paper was published.

Mr. J. H. HOVELL asked whether the fact that the wire was coiled had an essential bearing on the spring and enabled one to work within a definite length and to alter the length of the spring while not at the same time altering the distance of the application of the weight from the point of fixation. He had noticed that in one case there was a small difference between the

actual weight used, 14 oz., and the weight of $14\frac{2}{3}$ oz. on the spring, and he wondered whether that was merely within the limits of experimental error or whether the coiling of the spring in some way affected the tensile qualities. He felt that probably all the results were due to increase of length, and he would like to know whether any experiments had been carried out with springs which had not been coiled but were exactly the same length, in order to see whether there was any actual effect of the bending or whether it was merely the length of the distance of the application of the weight from the point of fixation.

Mr. MILLS, referring to the President's remarks, suggested that the President should have a word with Mr. Wild, who no doubt would have many points of common interest and common knowledge with the President, which latter he himself did not possess.

He did not know the answer to Mr. Hovell's question, but his impression was that the insertion of a coil simply caused an increase in the length of the spring. Mr. Hovell would remember *Figs.* 29 and 30. The distance *D*—*D*1 in *Fig.* 30 was equal to the circumference of the circle at *D* in *Fig.* 29, and it would appear that the increase in length of the spring was the effective factor. He thought that the difference between 14 oz. and $14\frac{2}{13}$ oz. was simply one of experimental error. He would mention the question to Mr. Wild and see what he said about it.

Mr. H. G. WATKIN said that he would like to thank Mr. Wild very much for his paper. He thought that orthodontists might use Mr. Wild's methods in their experiments on the action of various appliances on the teeth. They might use the two boxes and the sealing wax and paraffin, and then apply heat and see what happened. From point of view alone he thought that the paper was a very valuable contribution to the Society's proceedings.

Mr. MILLS said that he believed that the method had been used by Mr. Capon of Liverpool in connection with the twin arch. He thought that it would demonstrate the action of the twin arch very effectively.

THE PRESIDENT said that he would recommend an approach of the kind indicated in the paper to those who had not a great deal of experience of the working of springs in the mouth. His own view was that the mathematical approach, the theoretical approach and the experimental approach were of value mainly in shortening the period in which the orthodontist was " fumbling about " with appliances. It took orthodontists some time to become so familiar with the behaviour of the mechanical devices which they used, that they could predict how those devices would behave. In perfecting their approach to design, they would find it of very great assistance to try to analyse the behaviour of particular forms of mechanism theoretically and experiment with the mechanical devices, as Mr. Watkin had suggested, on some such lines as those adopted by Mr. Wild.

Ordinary Meeting preceded by a Special Meeting

held on 9th January.

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, January 9th, 1950, at 7.50 p.m., being *preceded by a Special Meeting*, at 7.30 p.m., for the purpose of discussing the Honorary Treasurer's report. Mr. L. Russell Marsh, the Immediate Past President, occupied the Chair at the Special Meeting and at the beginning of the Ordinary Meeting, being then succeeded by the newly elected President, Mr. H. T. A. McKeag.

The Minutes of the Annual General Meeting, held on December 12th, 1949, were read, confirmed and signed.

Mr. Harold Chapman (Hon. Treasurer), who, owing to illness, had not been able to attend the Annual General Meeting, then introduced his report, prefacing his remarks on the report by a reference to Miss Johanson, who had been elected an Honorary Member of the Society at the Annual General Meeting. Miss Johanson, he said, had been a member of the Society since 1925. He had met her at the Angle School in St. Louis in 1905, and he had seen her on only one subsequent occasion, namely, at the Second International Dental Congress in 1931. It was very sad to learn that she had become almost blind and had not practised for some years.

In regard to his report, some of the members had written to him and he had received messages from others, and in the remarks which he was about to make he would deal with the points which they had raised.

There were two reasons why the 1949 accounts must receive more attention than was usually given to the Society's accounts.

The first reason was that they disclosed a surplus of £6 on the year's working. The subscription had been raised to two guineas in 1948, when there was a deficiency of £60. In the table which had been circulated to the members it was stated that in 1948 there was a surplus of £136, and he had so stated in last year's accounts, assuming that what the Auditors had put down was correct, but, while it might be correct in a certain sense, there was in fact a deficiency on the year's working of £60, not a surplus of £136. Similarly, this year there was a surplus of £36, but, as the Council had sanctioned the expenditure of £30 on books which had not actually been paid for, the £36 became £6. He would ask the Auditors, who had drawn up the table, to make the results of the year's working clearer in future and to show whether there was in fact a deficiency or a surplus.

On the last two years, therefore, there was a deficiency of £54, so that, although the subscription had been raised to two guineas, the Society could not be run on the present subscriptions.

Secondly, there was a deficiency of £876 over the last seven years, which was a very serious matter. If the Society had not had some reserves its position would have been extremely difficult. The deficiency of £876 was nearly two-thirds of the Society's investments. It was masked, because the payments for the Transactions were so much behind the receipts, i.e., the subscriptions, which were to pay for them. The members had been complaining that they did not get their Transactions until very late, and that was an even more difficult matter for the Honorary Treasurer than it was for the other members. The Society still had (as from September 30th last) the following to pay for the Trans-

actions: £355 for 1946, £450 for 1948 and £450 for 1949 (the last two figures being estimated) making a total of £1,255.

Until four or five years ago, no provision had been made for these payments in the current accounts, because there was always a surplus and the amounts were not so large, but it was now very important that provision should be made for payment for the Transaction in the relevant year. Adjustments had to be made as the costs were known to advance and again when the actual figures were known. Such adjustments had all been upwards except for the year 1944-45.

Another item which had masked the position somewhat was that the bank balance included £405 which was capital. In 1947 the Society realised £780 from Savings Certificates and only £375 was re-invested in Savings Certificates, the balance of £405 being left in the current banking account. He had pointed this out to the Auditors and asked them to make the position clear next year.

In regard to the investment position, the investments totalled £1,380; the accounts for the years 1943-1949 showed a deficiency of £876, which reduced the investments to £504, and with the £30 for books, to which he had referred and which ought to be included, the investment position was reduced to £474. He would remind the members that there had been no subscriptions in 1940, 1941 and 1942, so that the expenses in those years were a charge on capital.

In 1949 the Society had just paid its way. The subscriptions amounted to £734, against which there were the Transactions, £450; other expenses, £248; sanctioned for books, £30; leaving a balance of £6.

In raising the subscription to two guineas in 1948, the Council realised that it was the minimum increase that would enable the Society to carry on. In two years there was a net deficiency of £54. Before 1939 there was an annual average surplus of £30 to £40, bringing the investments up to £1,400. The Society should budget for at least a similar surplus now, though its monetary value would be much less. This surplus could be achieved by an increased subscription rate or a reduced expenditure, e.g., on payments to readers of papers, refreshments, the library, or any other item.

The cost to the Society of those who attended the meetings regularly was greater than their subscription of two guineas. The Transactions cost £1 5s. 0d., some editions cost more, but £1 5s. 0d. was a round figure which was approximately correct. The refreshments, at 2s. per meeting, came to 14s., which sum added to the £1 5s. 0d., came to a total of £1 19s. 0d., leaving 3s. for other expenses, but in 1949 those other expenses amounted to 11s., so that those who attended the meetings regularly were being subsidised by those who did not do so. He did not think that any of the members wished to place themselves in that position. If a member who attended all the meetings brought a visitor to one meeting, that meant another 2s. for refreshments, leaving only 1s. of the subscription for other expenses. Mr. Cutler had pointed this out at the last meeting, though perhaps not in quite so much detail.

There was therefore a case for raising the subscriptions of those who were most likely to attend the meetings, namely, those in the London postal area. There were 131 such members, and if their subscriptions were raised by 10s. 6d. it might enable the Society to make ends meet, but in 1948 there was a deficiency of £60, so that a larger increase, say to three guineas (not an excessive figure in the circumstances of to-day) was necessary if the Society was to avoid further inroads into its reserves and to have an opportunity of building them up in the future. The Council would have the 1950 accounts placed before it for consideration before it made a proposal to the members at the next Annual General Meeting.

tendency to rely on it to an increasing extent, and a balance must be maintained between the two types of contribution.

Sixthly, the Society should aim at having a minimum surplus of £50 per annum. He thought that was on the low side and he would like someone to suggest a higher figure.

Finally, the Society should have its own premises, library and museum. It would be very much better if the library and the museum could be in Manson House. Someone had been to visit the museum at the Institution of Public Health and Hygience in the adjoining premises and had been told that they knew nothing about the B.S.S.O., that they had nothing to do with it, and so on.

He did not think that the programme which he had put forward was an unduly ambitious one.

The Society was not alone in its difficulties. The Royal Society of Medicine proposed to raise its subscriptions for Fellows in the London area from five to seven guineas next October. The American Dental Association had raised its subscription in 1948 from $6 to $12, and in 1949 the subscription had been increased to $20, a more than threefold increase in three years. The cost per member had increased nearly three times between 1941 and 1949, and nearly half the reserves of the Association, about £100,000, had been drawn upon. The European Orthodontic Society was to have its Transactions printed in Holland and to hold its meeting every other year, whilst maintaining its annual subscription. The European Orthodontic Society, the French Orthodontic Society and the British Society for the Study of Orthodontics were, as far as he knew, the only orthodontic societies to publish their transactions in book form. The American Association of Orthodontists published papers read before it and its affiliated societies in the American Journal of Orthodontics and was not printing them in a volume, owing to the exhorbitant cost of so doing. It considered that publication in the American Journal of Orthodontics constituted a sufficient record but he thought there must be a number of papers which were not published or appeared elsewhere than in the American Journal of Orthodontics. It had been suggested that the American Association of Orthodontics had ceased publishing its transactions in book form in 1945, but he was a member of that Association and he did not remember seeing a volume of Transactions as recently as 1945. He had not any information in regard to the Dutch Orthodontic Society.

It would have been gathered from what he had said that he was not in favour of reducing any of the Society's activities, all of which were necessary for a live society, and he hoped that, when the time for it came, all the members would express themselves in no uncertain manner in favour of all the Society's activities being maintained.

He would like to enlarge upon much that he had said, but he wished to leave plenty of time for the members to express their views and for the President's Address.

The CHAIRMAN said that it was not proposed to take any decision at the present meeting on the question of increasing the subscription. The Council would consider the matter again but would welcome any views from the members on the subject of the Society's financial affairs and any suggestions for improving them.

Mr. DIXON, speaking as a member living outside the London area, said he thought that most of such members would like to share in the payment of an increased subscription if an increase was made.

Two other members supported Mr. Dixon's view.

The CHAIRMAN asked those members who were prepared to consider an increase in the subscription rather than a curtailment of the Society's activities to indicate that by a show of hands, and a large number raised their hands.

Those who had studied the expenditure account would have noticed an absence of any petty cash expenses for the Curator, the Librarian and the Editor. How they carried on so successfully without calling on the treasury he did not know; he could not believe that they were in receipt of Marshall Aid or anything similar, unless it were from their own pockets. In any case, wherever the money came from, the thanks of the members were due to them. (*Applause*).

The Society's finances had to be considered on broad lines. What were the subscriptions for? They were for current expenses and future development, and, if the members were sympathetic towards those objects, surely they would provide the finance to pay for them.

He wished to express his own views on the matter and to put them before the members for their consideration. He had been associated with the Society since its inception, probably having attended all the preliminary meetings before the Society was actually founded, as he had been associated with the founder, Dr. Northcroft, since his return from the Angle School at St. Louis. During that period he had frequently dined with Dr. Northcroft and had had many discussions with him on orthodontic problems. For many years he had been on the Council of the Society in one position or another, so it would be realised that he was keenly interested in the Society's welfare, and the suggestions which he had to make would be, he hoped, for the good of the Society.

Many years ago, long before he became Honorary Treasurer of the Society, someone had asked him why the Society should accumulate a surplus, and he had replied that it was so that the Society could have its own premises, its library, museum, and so on. It was then that he had realised that the Society should have an ambition; in this he hoped the other members agreed with him then he hoped the members to-day also supported that view, but he had not realised what changes could occur so suddenly to disperse so much of the Society's resources in so short a time.

In his view the Society's ambition should be as follows.

First, it should remain independent. Some of the members would not remember that it had at one time been suggested that the Society should become affiliated with another organisation. He thought it would have been to the detriment of the Society if that had been done.

Secondly, he thought the Society should control its own Transactions and publish the papers read before it through the medium of a dental journal as well as in a volume of its own. The circulation of the Transactions was limited to the members and thirty extra copies were printed, five or six which were reserved for the library. Publication in a dental journal gave the papers read before the Society a wider circulation.

Thirdly, the Society should meet in scientific session. The importance of that was obvious and he need not enlarge upon it.

Fourthly, the members should meet in social session after the scientific meeting. That was a little more controversial, but he was firmly of the opinion that the meetings in social session were just as important as the scientific sessions, because the members met and got to know one another and continued their discussions on an informal yet invaluable plane. He would be very sorry if the social sessions were discontinued. Some societies held a dinner, but in his opinion the procedure adopted by the Society was more satisfactory and should be encouraged.

Fifthly, the Society should hold a least seven meetings a year. (Originally the number was eight). A society of 350 members should easily support this without outside aid. He was not opposed to outside aid (he had encouraged it in the past, and still did so), but there was a

The CHAIRMAN said that this indication of the members' views would be most gratifying to the Council.

Mr. HAROLD CHAPMAN agreed.

This concluded the proceedings of the Special Meeting, and the Ordinary Meeting then began.

Mr. L. RUSSELL MARSH said that, much to his surprise, he found himself reluctant to leave the Presidential Chair. A year ago he had expressed his very great appreciation of the honour of being President of the Society, and during the year all the members had been very kind and indulgent to him. There had been no demonstrations and no protests, and he could only regard that as another illustration of the long-suffering acquiescence of the British public. He thanked the members for their courtesy and would now return to the obscure corner from which he had come.

He wished also to thank the members of the Council for their kind and loyal support, and in particular he thought that thanks were due to the Honorary Secretary and the Honorary Treasurer.

Before leaving the Presidential Chair he would like to say a word to the younger members. The Society tried to encourage its younger members, and he would urge them to submit casual communications. They should not refrain from doing so because they thought their communications were too trivial. If they sent them to the Honorary Secretary, he would tell them whether or not they would be acceptable to the Society.

His last duty was to introduce the new President, Mr. McKeag. He himself had been sandwiched between Professor Rushton and Mr. McKeag, and that sandwich had the bread in the middle and the meat outside. Many members of the Society knew Mr. McKeag very well indeed, but others didknow him not so well, because he lived in Belfast and therefore could not attend the meetings of the Society so often as he would like to do. He hoped that Mr. McKeag would be present more often during the coming year.

Mr. Keag's publications had been a valuable asset to orthodontic knowledge. The members would recollect in particular his work on stainless steel, especially in the early days, and he himself had in mind an excellent paper by Mr. McKeag and Professor Friel, in 1938, on stainless steel appliances.

Mr. McKeag was Lecturer in Orthodontics at Queen's University, Belfast, a position to which he had been appointed on its inception in 1920.

Mr. Russell Marsh then invested Mr McKeag with the Presidential Badge and inducted him into the Presidential Chair.

Mr. R. E. RIX, in proposing a vote of thanks to Mr. Russell Marsh for conducting the Society's affairs so ably during the past year, said that it had been a very busy year for him and his ill health during the early part of it had not prevented him from going to America and forming valuable contacts with orthodontists in that country. He had demonstrated before the American Association of Orthodontists in New York in May.

The members of the Society had appreciated Mr. Russell Marsh's dry humour and quiet efficiency and his wide interest in orthodontics. They hoped that, now that he was restored to health and free from the onerous duties of the President, he would enjoy sitting with the members in the body of the hall for a long time to come.

The vote of thanks was accorded with acclamation.

The PRESIDENT then welcomed the visitors who were present at the meeting.

Mr. E. J. R. BIRD, a recently elected member, was introduced to the President and signed the Obligation Book.

The following candidates for membership of the Society were elected *en bloc* by show of hands:

J. M. Alexander, L.D.S.(Eng.), Field House, The Parks, Minehead, Somerset.

E. T. Barlow, L.D.S.(Eng.), Downsholme, Lawns Avenue, Eastbourne.

H. D. Freeman, L.D.S.(Eng.), 20, Paul's Crescent, Botley, Oxford.

J. E. Jones, L.D.S.(Eng.), Gowerdale, Lloyd Street, Llandudno.

M. Taralrud, L.D.S.(Oslo), D.M.D.(Berlin), L.D.S.(Eng.), 47B, Welbeck Street, W.1.

The President then read his address entitled *Orthodontics in my Time*.

Mr. K. E. PRINGLE, in proposing a vote of thanks to the President for his excellent Address and for accepting the office of President of the Society, said the fact that Mr. McKeag had to come all the way from Ireland to preside over the Society showed his enthusiasm for orthodontics and his willingness to sacrifice himself for that subject. (*Applause*).

The members had known Mr. McKeag's work for many years, and his Address on the present occasion had reached his usual very high standard. He had been interested in the President's reference to the chaos which existed in orthodontics at the present time, because it made him feel that the President knew the same things as he knew, and he believed that the chaos to which the President had referred masked something which was gradually growing up amongst orthodontists.

Mr. HUDSON, in seconding the vote of thanks, said that the President's enthusiasm, loyalty and erudite contributions to the subject of orthodontics were well known to the members and they were very grateful to him for his Address. They trusted that, whichever route he chose for his journeys to England, the sea would be calm and he would have a most pleasant experience.

The vote of thanks was accorded with acclamation.

The PRESIDENT, in acknowledging the vote of thanks, said that, in view of his duties in Belfast, he had felt that he ought to relinquish the Presidency of the Society, which in a rash moment he had accepted, but as he regarded it as the greatest honour in the realm of British orthodontics he had not been able to make so great a sacrifice.

Ordinary Meeting

held on 18th February.

AN ORDINARY MEETING of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, February 13th, 1950, at 7.30 p.m. Mr. H. T. A. McKeag, President, occupied the Chair.

The Minutes of the previous meeting, held on January 9th, 1950, were read, confirmed and signed.

The President welcomed the visitors who were present and expressed the hope that they would take part in the discussions at the meeting.

The following recently elected members were introduced to the President and signed the Obligation Book: Mr. Barlow, Mr. Freeman, Mr. R. D. Ogston, and Mr. M. Taralrud.

The following candidates for membership of the Society, approved by the Council, were elected *en bloc* by show of hands:

Lieutenant Hans L. Eirew, L.D.S., V.U. Manchester, 255, Wilmslow Road, Fallowfield, Manchester, 14.

Mr. J. E. Rydemark, D.M.D., L.S.T., L.D.S., R.C.S.(Eng.), 8, Devonshire Place, W.1.

Mr. S. Robinson, F.D.S., R.C.S.(Eng.), 14, Wimpole Street, W.1.

Mr. D. F. Soul, F.D.S., R.C.S.(Eng.), 261, The Drive, Ilford, Essex.

In the absence of Miss Smyth, the following short communication was read by Mr. D. F. Glass: '*Obliteration of the Pulp Canal at age of* 13 *years* 9 *months after a blow at* 7 *years.*'

This was followed by another short communication entitled: '*Two Cases of an Unerupted Deciduous Molar*' by W. J. Tulley.

The PRESIDENT said that the paper expected from Mr. Broadbent had not been obtainable, owing to his illness and retirement, and Mr. Hovell had very kindly stepped into the breach and prepared a paper at somewhat short notice.

Mr. J. H. Hovell then presented his paper entitled: '*Aetiological Approach to Orthodontic Diagnosis.*'

Special Meeting

held on March 13th, 1950.

A SPECIAL MEETING of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, 13th March, 1950, at 7.15 p.m., for the purpose of considering a proposed amendment of Bye-law XII. Mr. T. H. A. McKeag, President, occupied the Chair.

Mr. HAROLD CHAPMAN (Honorary Treasurer) moved the following resolution put forward by the Council:

"That Bye-law XII be amended to read as follows:

> "From January 1, 1951, every person elected an Ordinary Member shall pay an annual subscription of three guineas. The subscription of a Member joining the Society within three years of obtaining a registrable dental qualification shall be two guineas per annum until December 31 next occuring after the expiration of the period of three years from the date of such qualification. The subscription of Corresponding Members shall be one and a half guineas per annum'."

In explaining the reason for the proposed amendment, he said that those who had been present at the meeting in January would remember that he had pointed out that on a two-guinea subscription the Society could not be run in the way in which it should and the members could not have the amenities to which they were accustomed. The effect of the proposed amendment would be to raise, as from 1st January, 1951, the subscription of Ordinary Members from two to three guineas, except in the case of those recently qualified, whose subscription would be increased by half a guinea to two guineas for the first three years, and the subscription for Corresponding Members would remain at its present figure of £1 11s. 6d.

At the meeting in January he had made a full statement of the Society's financial position, and he would only say now that in 1948 the Society had a deficiency of £60 and in 1949 a surplus of £6, so in the two years it had a deficiency of £54. It was obvious, therefore, that the Society

could not continue to be run in its present way at the present subscriptions, and it was probable that the expenses would increase rather than decrease.

The reason for taking action in the matter so early in the year was to give time for the amendment of bankers' orders, which began to be passed for payment early in October, so that the October meeting would be too late for the matter to be dealt with, and the May meeting was a demonstration meeting when it was not convenient to discuss such matters.

Mr. O. N. CATCHPOLE formally seconded the resolution.

The PRESIDENT, in inviting discussion on the resolution, said that the finances of the Society had been considered very carefully and thoroughly by the Council, and the Council had decided that it had no alternative but to recommend the alteration of the Bye-laws which was now proposed.

Mr. ROBERT CUTLER moved as an amendment that there should be added to the proposed amended Bye-law a statement that the annual subscription for those Ordinary Members who had already paid 25 annual subscriptions should remain at two guineas.

It might be remembered, he said, that at the meeting in December last he had drawn attention to the danger of increasing the subscription and to the anomalies created by a deficit in the year's working being occasioned by a single item, namely, refreshments, in which only those present at the meetings, including visitors, shared, so that in effect the refreshments were paid for out of the subscriptions of those members who were not able to attend. At the following meeting Mr. Chapman had made a statement, a transcript of which he had been so kind as to send him, covering wider and less parochial issues.

The Council had fully weighed the danger of increasing the subscription, and it might be ungenerous to oppose the resolution, but he wished to stress that danger. If there were 300 members paying a subscription of £2 the subscription income was £600, and if they paid a subscription of £3 the subscription income was £900. If 50 members resigned on account of the increase in the subscription, there would be 250 members paying a subscription of £3, so the subscription income would be £750, only £150 more than the subscription income received from 300 members paying a subscription of £2, and that was not such an increase as would enable the Society to carry out the schemes envisaged by Mr. Cutler.

With regard to the amendment that he had proposed, he thought that it would cover the bulk of the members who did not regularly attend the meetings but those whose good will the Society should not lightly forgo. Without them the Society could not continue in a solvent condition, and, even if it could, the enforced resignation of any material number of senior members who did not habitually attend the meetings but remained members out of good will and comradeship would create a gap which it would be difficult to fill.

In effect the Council was following the financial policy of the present Government in raiding national assets to meet current expenditure. The assets of the Society were the good will of a large body of members who did not attend the meeting but who, out of comradeship and a desire to help the Society, were ready to pay their subscriptions. He did not think their forbearance should be taxed in the way suggested.

He would add that he himself did not come into the category of members who had paid 25 annual subscriptions.

Mr. R. E. RIX formally seconded the amendment.

Mr. R. B. DOCKERELL, speaking as an Irish member, said that he could not refrain from protesting against the Council's proposal. If the Society could not remain in existence and fulfil its scientific function without the subscription being increased,

he would readily agree to an increase, but he felt that to increase his subscription in order to serve coffee and buns to the London members was going a little too far. He was very glad to receive the Society's Transactions but he could very seldom come to a meeting of the Society, and it appeared that there were a few Irish members who were going to be asked to pay extra for the coffee of the London members and some provincial members who attended the meetings regularly.

Mr. C. P. ADAMS said that he also was an Irishman, but he was living in London. He entirely agreed with Mr. Dockerell's point of view. An overall increase in the subscription would fall very heavily on members who were not able to attend the meetings as regularly as the London members could, and he would suggest that the subscription of the London members should be increased but that the subscription of the other members should remain at the present figure. He was inclined to agree with Mr. Cutler's suggestion that some charge should be made for the refreshments which were provided after the Society's meetings.

Mr. K. E. PRINGLE said that he was in sympathy with Mr. Cutler's view with regard to the older members, but it was very important at the moment that no one should become a charge on the Society.

Speaking as the past Secretary of the Society, he was sure that it would be very pettifogging for the Secretary and all the members if a small charge for refreshments was made at each meeting of the Society, and he thought it would be impracticable.

With regard to the suggestion that London members should pay a larger subscription than the other members, it was true that London members had an opportunity of attending meetings of the Society more often than other members, but there was a considerable number of London members who did not attend any more frequently than many of the members in the provinces. The Council had considered this suggestion already and thought it would be very difficult to know where to draw the line for the London members, whether it should be, for instance, fifty miles from London or nearer or further.

He would like to ask the Honorary Treasurer whether he had any idea of the number who had been members for over 25 years. He thought it was very small.

Mr. HAROLD CHAPMAN said he was sorry that he could not answer Mr. Pringle's question.

He would point out that if a certain number of members resigned it would not reduce the cost of the Transactions. If thousands of copies were required it would be a different matter, but, as there were only 350 members of the Society, the cost per copy would be the same if there were only 200 members, and the cost per volume would be about one-half of the subscription if the subscription was three guineas; at the present moment the cost per volume was about three-quarters of the subscription. He thought that that invalidated some of Mr. Cutler's arguments.

Mr. Pringle had dealt very ably with the question of refreshments. The Council had considered very carefully the suggestion that a charge should be made for the refreshments, and every member of the Council, including himself, agreed with Mr. Cutler's views, but, as Mr. Pringle had said, it would be very difficult to put the suggestion into operation. Some years ago the Metropolitan Branch of the British Dental Association had made a charge for refreshments after its meetings, but it had never been possible to collect the charge satisfactorily, and finally it was given up and the refreshments also were given up. It seemed to him that, if the members who attended the meetings of the Society did not want to be subsidised by the other members, the refreshments would have to be given up, but he felt that the meeting in the library where the refreshments were served was nearly as

important as the meeting which preceded it, and he was therefore prepared to let the charge for refreshments remain a charge on the Society as a whole, just as the cost of the meeting was.

The amendment proposed by Mr. Cutler was then put to the meeting and was lost, 3 voting in favour and 27 against.

The resolution was then put and was carried, 39 voting in favour and 1 against.

Ordinary Meeting

held on 13th March.

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, 13th March, 1950, at 7.30 p.m. Mr. H. T. A. McKeag, President, occupied the Chair.

The Minutes of the previous Ordinary Meeting, held on 13th February, 1950, were read, confirmed and signed.

The Secretary announced that members of the Society were invited to attend the 46th Annual Session of the American Association of Orthodontists, to be held in Chicago from May 8th to 11th.

The President welcomed the visitors who were present and invited them to take part in the discussions at the meeting.

Lieutenant H. L. Eirew, a recently elected member of the Society, was introduced to the President and signed the Obligation Book.

The following candidates for membership of the Society were elected *en bloc* by show of hands:

Miss P. A. Watkins, L.D.S.(Eng.), 84, Rodney Street, Liverpool, 1.

Mr. L. H. Valentine, L.D.S.(Eng.), Alma House, Rodney Road, Cheltenham.

Mr. C. W. Audsley, L.D.S.(Eng.), Denbigh House, George Street, Ryde, Isle of Wight.

Mr. R. O. Hellier, L.D.S.(Eng.), 90, Holton Road, Barry, Glamorgan.

The following short communication was then read by Mr. D. F. Glass: '*A case of an Unerupted First Permanent Molar, with Second Premolar and Second and Third Molars in Position.*'

Professor H. F. Humphries and Mr. B. C. Leighton then presented a paper entitled: '*Factors in the Aetology of Post Normal Occlusion.*'

Demonstration Meeting

held on 8th May

The Demonstration Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1. on Monday, May 8th, 1950,

The Minutes of the previous Ordinary Meeting, held on March 13th, 1950, were read, confirmed and signed.

The following candidates for election were admitted en bloc:

Mr. A. S. Carr, L.D.S., (Eng.) 62, Ambleside Avenue, Walton-on-Thames.

Mr. R. J. Heylings, B.Ch.D. M.B., Ch.B (Leeds), c/o The Dental De-

partment, Saint Bartholomew's Hospital, E.C.1.

MR. H. L. LEFCOVITCH, L.D.S., (Eng.) 86, Humberstone Drive, Leicester.

MR. P. C. GRUMMIT, B.D.S., (Eng.) c/o Dental Department, Guy's Hospital, S.E.1.

The following Demonstrations were given:

MR. RUSSELL MARSH: *A Modified Crozat Appliance using Stainless Steel.*

MR. NORMAN GRAY: *Simplified Crozat Type Appliance using Stainless Steel.*

MR. WALPOLE DAY: *The Effect of the Condylar Cartilage on the Growth of the Mandible.*

MR B. R. TOWNEND: *Twins.*

MR. J. H. GARDINER: *The Adaptation of Stock Pliers for Orthodontic Use.*

MR. HAROLD CHAPMAN: *Extra Oral Anchorage.*

MR. C. P. ADAMS; *A Method for Teaching the Fundamentals of Wire Bending Technique.*

MR. H. E. WILSON: *The Progressor.*

Ordinary Meeting

held on 9th October.

AN ORDINARY MEETING of the Society was held at Manson House, 26, Portland Place, London, W.1., on Monday, October 9th, 1950, at 7.30 p.m. The President, Mr. H. T. A. McKeag, occupied the Chair.

The Minutes of the previous meeting, held on Monday, May 8th, 1950, were read and confirmed.

The PRESIDENT said he had two announcements to make.

Unfortunately, Mr. Symons, owing to a difference of opinion with his appendix, was unable to be present. Dr. Scott, who it would be remembered, had given a paper on an anatomical subject some twelve months previously, had been in touch with Mr. Symons over part of the period during which the paper that was to have been given that evening had been in preparation, and he would read the paper on Mr. Symon's behalf. They were very much indebted to him for this and looked forward to a successful evening.

Secondly, the European Orthodontics Society was holding a meeting at Lillehammer in Norway on June 7th to 14th, 1951.

He then welcomed any visitors who might be present and invited them to contribute to the discussion should they feel so inclined.

Five members who were attending for the first time were introduced to the President.

The following candidates for election were admitted *en bloc*:

Miss E. M. E. Bonnar, L.D.S., Q.U. Belf., Ballycraigy House, Carmoney, Co. Antrim, N. Ireland.

Miss A. Panter, L.D.S.(Eng.), 35, St. Alban's Road, London, N.W.5.

Major M. F. Porterfield, L.D.S.(Eng.), R.A.M.C. Mess, Ross Barracks, Shorncliffe, Kent.

Dr. A. L. H. Bakry, B.CH.D.(Cairo), L.D.S.(Eng.), 13, Sherif Pacha Street, Cairo, Egypt. (Corresponding Member)

The President called upon Mr. W. J. Tulley to give a Short Communication.

There being no further contribution to the discussion, the President called upon Dr. James Scott to read Mr. Symons' paper on "Studies in the Growth and Form of the Mandible."

Dr. James Scott said he had been asked to discuss the paper, and it was somewhat of a somersault to find himself presenting it instead. He was not sure whether he was supposed to discuss it as well. Everyone would be sorry, however, that the person who had put so much work into it was unable to present it himself. Indeed, he had found Mr. Symons rather depressed when he had seen him on Sunday night, because this was to have been his first attempt at addressing a meeting of this kind, and he had been looking forward to it.

Dr. Scott then gave a summary of the paper, which was accompanied by slides.

Ordinary Meeting

held on 13th November.

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1., on Monday, November 13th, 1950, at 7.30 p.m. Mr. H. T. A. McKeag, President, occupied the Chair.

The Minutes of the previous meeting, held on October 9th, 1950, were read, confirmed and signed.

The President extended a cordial welcome to Dr. Gugny (Paris), Professor Hotz (Zurich), Professor Selmer Olsen (Oslo), Dr. Duyzings (Utrecht) and Mr. Gaare (Oslo). Some of these gentlemen, he said, were Honorary Members or Corresponding Members of the Society, and they were all the more welcome on that account, but those of them who were not such members were still very welcome on their own account.

The following recently elected members were introduced to the President and signed the Obligation Book: Major Porterfield and Miss Watkin.

The following candidates for membership of the Society were elected *en bloc* by show of hands:

Mr. D. R. Burnapp, L.D.S., Eng., 18, Ingleby Way, Wallington, Surrey.

Mr. P. J. Comrie, L.D.S., B.D.S.U., St. Andrews, Hope Park, 15, Victoria Road, Broughty Ferry West, Dundee, Angus.

Mr. G. S. Ritchie, L.D.S.U., St. Andrews, 146, Nethergate, Dundee, Angus.

Mr. B. N. Watkins, D.D.O., R.F.P.S. Glasgow, L.D.S. Edin., 3, Castle Street, Ludlow, Shropshire.

Mr. G. B. Hopkin, L.D.S.U. Leeds, H.D.D. Edin., Havercroft, Lamplugh, Workington, Cumberland.

Mr. R. A. Abbey, L.D.S. Eng., 15, Arundel Road, Eastbourne, Sussex.

The President, in introducing Professor Wood Jones, who was to deliver the Fourth Northcroft Memorial Lecture, said that the Northcroft Memorial Lecture had been instituted in memory of a great member of the Society and a great student of orthodontics. It would certainly have been very acceptable indeed to him that the Lecture should be given by one who was not an orthodontist, because no one recognised more clearly than George Northcroft that the best foundation for the study of the abnormalities with which orthodontists had to deal was the study of the normal.

The following Lecture was then delivered: *The Human Jaws and Dentition* by Professor F. Wood Jones.

Annual General Meeting

held on 11th December.

The Annual General Meeting of the Society for the year 1950 was held at Manson House, 26, Portland Place, London, W.1., on Monday, 11th December, 1950, at 7 p.m. Mr. H. T. A. McKeag the retiring President, occupied the Chair.

The Minutes of the Ordinary Meeting held on 13th November, 1950, were read, confirmed and signed.

The President announced that the following Officers for 1951 had been nominated by the Council and, no further nominations having been received, he declared them duly elected:

President: Miss L. M. Clinch.

Immediate Past President: Mr. H. T. A. McKeag.

Vice-Presidents: Dr. L. Lindsay, Mr. J. F. Pilbeam, Mr. Trevor Johnson and Mr. K. E. Pringle.

Secretary: Mr. Howell Richards.

Treasurer: Mr. H. Chapman.

Curator: Mr. W. J. Tulley.

Editor: Mr. C. F. Ballard.

Librarian: Mr. A. G. Taylor.

A ballot was then held for the election of three Councillors, four members having been nominated. Mr. C. P. Adams and Mr. Robinson were appointed scrutineers of the ballot, and the following were elected: Mr. J. S. Beresford, Mr. J. H. Hovell and Mr. W. Russell Logan.

On the motion of Mr. J. S. Beresford, seconded by Mr. J. W. Softley, Mr. S. B. Newton and Mr. T. L. Winn were unanimously elected as Auditors for the year 1951.

The Hon. Treasurer (Mr. H. Chapman) reported that the year's working had resulted in a deficiency of £91 10s. 0d., which, added to the deficiency occurring between the years 1943 and 1949, made a total deficiency of £967. It was hoped that, as the subscription next year would be three guineas, the position would now change and the Society would no longer be run at a loss. It must be borne in mind, however, that the cost of printing might increase even more than had been allowed for. The item of £571, cash at bank, included the sum of £405, being the uninvested portion of the realisation of Savings Certificates in 1947. Even so, if the Society were to be wound up at the end of this year a further £500 would be needed from capital to meet the Society's indebtedness.

He moved that the Report be adopted.

The motion was seconded by Mr. K. E. Pringle and was carried unanimously.

The Hon. Secretary (Mr. Howell Richards) reported that during the past year seven meetings had been held, with an average attendance of 78.

Twenty-three resignations would become effective from 31st December, 1950, and three members had died during the year.

The new members, including the Corresponding Member to be elected at the present meeting, totalled 28, so the total membership of the Society was much the same as it had been at the end of last year. He thought the Society was to be congratulated on the fact that the increased subscription announced in March had not resulted in a greater reduction in membership.

He wished to stress again the importance of members and visitors signing the attendance book, as this enabled the staff at Manson House to be given an accurate idea of the number to expect for refreshments.

He would like personally to thank Mr.

Chapman for his forbearance in dealing with his many queries on procedure.

He moved the adoption of the Report.

Mr. A. G. Taylor seconded the motion, and it was carried unanimously.

The Hon. Secretary said that there was no Report from Mr. Ballard, the Hon. Editor, who was unable to be present at the meeting, but he had to announce that the Transactions for 1949 would be published in January and would be sent to the members as soon as they were available. There had been some delay owing to the recent printers' dispute.

The Hon. Librarian (Mr. A. G. Taylor) reported that the latest edition of Strang's Textbook on Orthodontia had been purchased this year. Gifts of books, including past Transactions of the Society, had been received from Mrs. Michaelis and Mr. Chapman, and the old Minute books of the Society had been deposited in the Library by Mr. Robert Cutler, past Secretary.

He hoped to give members a better service for looking up articles on various subjects.

In the past two or three years many sales of volumes of the Society's Transactions had taken place, from single volumes to almost complete sets. The Council of the Society had fixed a price of one guinea for volumes up to 1939 and thirty shillings for volumes after that date. There were no spare copies of the Transactions for 1924, 1927, 1940-41, 1942-43 and 1947 for sale, and there was only one spare copy of the Transactions for 1930 and the Transactions for 1944. As a result, he had had to rely on chance gifts to build up some of the sets which had been sold, but that method was now practically at an end. If any members had copies to spare he would always be glad to receive them. Even the Library was deficient in the issues from 1906 to 1912.

Any member who wished to borrow books from the Library would find his name and address on the back of the 1951 Programme which the Secretary would be sending out soon. The Library was housed with the Museum at 28, Portland Place.

He moved the adoption of the Report.

The motion was seconded by Miss K. C. Smyth and was carried unanimously.

The Hon. Curator (Mr. W. J. Tulley) reported that during the past year models had been received from Miss Still, Miss Clinch and Mr. C. I. Hagger. These included a case of marked lip sucking with lower incisors retroclinated to an extreme degree, a case of partial anodontia and models of monozygotic twins showing mirror imaging.

An illuminated address from the President and members of the Cuban Orthodontic Society would be displayed in the Museum.

It was important for the further development of the Museum that members should be encouraged to contribute more material. The type of material required was (1) models of interesting cases with X-rays and photographs if possible, (2) treated cases with models taken before and after treatment, (3) serial models, and (4) appliances of historical or special interest.

For the information of new members he would add that the Museum was housed in the Museum of the Institute of Public Health and Hygiene at No. 28, Portland Place. The part allocated to the Society was in the Curator's room and was open from 9.30 a.m. to 5 p.m.

He moved the adoption of the Report.

Miss J. G. Ritchie seconded the motion, which was carried unanimously.

The President moved, on behalf of the Council, that Mr. J. E. Spiller, of 64 Worple Road, London, S.W.19, be elected an Honorary Member of the Society. Mr. Spiller, he said, had been an active member of the Society for many years and had now retired.

Mr. H. Chapman, in seconding the motion, said that he had known Mr. Spiller since the inception of the Society. They had been demonstrators together at

Guy's Hospital about the year 1908. During the first world war Mr. Spiller had been President of the Society for four years.

The motion was carried with acclamation.

The following candidate for election as a Corresponding Member of the Society was duly elected by show of hands: Mr. H. G. H. Gillett, L.D.S., 42 Strand Street, Cape Town.

The PRESIDENT announced that the Council had received a request from the British Dental Association that the members of the Society should be informed that the Annual Meeting of the Association in 1951 would include a demonstration meeting and that offers of demonstrations would be welcomed by the Association. The Council hoped that members of the Society would contribute to the demonstration meeting.

Visitors were then admitted and were welcomed by the President.

The following recently elected members were introduced to the President and signed the Obligation Book: Mr. R. A. Abbey, Mr. D. R. Burnapp and Mr. B. N. Watkins.

MR. NORMAN WILD then presented a paper entitled: *The Design and Behaviour of Orthodontic Springs.*

On the motion of the President, a vote of thanks was accorded to Mr. Wild for his paper, and the Secretary was asked to convey to Mr. Wild the members' appreciation of his paper and their regret at his inability to be present at the meeting. A vote of thanks was also accorded to Mr. Mills for presenting the paper.

The President said that his year of office had now come to an end, and before retiring he would like to thank the members of the Society for the support which they had given him and for their good attendance at the meetings. He would also like in particular to thank the Secretary and Treasurer, as well as the members of the Council, for the zeal which they had displayed in making the meetings of the Society so successful during his year of office, and for the help which they had given him, as a country cousin who was not so familiar with the conduct of the business of the Society as were many of the London members.

As a provincial member, he would like to suggest that possibly the time had come or would soon come when the Society might consider holding one meeting in the year outside London. It seemed to him that orthodontics had now reached such a position that the provinces might respond to a missionary effort on the part of the Society, and he thought that the number of provincial members was already sufficient to justify the holding of a meeting elsewhere than in London from time to time.

In introducing Miss Clinch, the President for the year 1951, he would like to say that Miss Clinch had displayed the utmost zeal in the conduct of the Society's affairs. As an officer of the Society in some of the less conspicuous but more active posts, she was known to all the members. He would suggest that on some informal occasion the Society might ask Miss Clinch to give the members a talk on Rugby football, as they might find her as interested in that subject as in the subject of orthodontics.

The Retiring President than invested Miss Clinch with the President's Badge of Office and installed her in the Presidential Chair.

The President (MISS CLINCH) said she had but to remember that the only other woman who had sat in the Presidential Chair of the Society was Dr. Lindsay to realise how inadequate she was for the position, but she would do her best.

MR. C. P. ADAMS, in proposing a vote of thanks to the retiring President for having conducted the Society's affairs during the past year, said that it was hardly necessary for him to stress the eminence and wisdom of Mr. McKeag not only in the field of the science and practice of ortho-

dontics but also in matters appertaining to dental education and to the problems confronting the dental service to the commuinty as a whole. Mr. McKeag's contributions to dental literature showed his vivid insight into the scientific and administrative problems of dentistry to-day. His understanding of the fundamental nature of the subject made him a man whose advice was very much sought after, and he was always ready to sacrifice for his own time and interests in order to help anyone who asked for his assistance. The members realised that Mr. McKeag was a very hardworked and busy man, and they greatly appreciated his having undertaken the further duties of the President of the Society, which involved his making a long journey over sea and land to attend the Society's meetings and a corresponding tax on his time and energy. The members wished him to know that, in vacating the Presidential Chair, he took with him their gratitude for having filled the office with such grace and distinction and their best wishes for the future.

The vote of thanks was accorded with acclamation, and, the retiring President having thanked the meeting, the proceedings terminated.

THE BRITISH SOCIETY FOR THE STUDY OF ORTHODONTICS

Balance Sheet and

Income and Expenditure Account

FOR THE YEAR ENDED 30th SEPTEMBER, 1950

FREDK. B. SMART & COMPANY, CHARTERED ACCOUNTANTS

22, Queen Street, London, E.C.4.

THE BRITISH SOCIETY FOR THE STUDY OF ORTHODONTICS

INCOME AND EXPENDITURE ACCOUNT for the Year ended 30th September, 1950.

1949											
£	s.	d.		£	s.	d.	£	s.	d.	£	s.	d.
10	10	0	To Storage Rent				10	10	0			
58	16	10	,, Printing and Stationery ..	79	16	11						
1,004	12	6	,, Reserve for Cost, 1950 Transactions	501	0	1						
							580	17	0			
26	11	10	,, Postage				36	18	4			
3	17	6	,, Lantern and Film Expenses ..	1	10	0						
45	0	0	,, Hire of Hall	45	0	0						
31	10	0	,, Reporting	31	10	0						
55	0	0	,, Refreshments	56	8	0						
							134	8	0			
	7	11	,, Telephone and Telegrams ..					2	4			
	5	3	,, Travelling Expenses					—				
5	5	0	,, Audit and Accountancy ..				5	5	0			
3	4	6	,, Insurance				3	7	11			
11	4	6	,, Library and Journals ..				24	14	0			
			,, Northcroft Memorial Lecture:									
26	5	0	Expenses of Prof. R. Selmer Olsen				43	9	5			
1	12	0	,, Sundries					15	4			
			,, Depreciation:									
30	11	6	Furniture and Office Equipment				30	11	6			
£1,314	14	4					£870	18	10			

1949											
£	s.	d.		£	s.	d.	£	s.	d.	£	s.	d.
			By Members' Subscriptions:									
			1950 Subscriptions	717	13	6						
734	3	11	1949 Subscriptions paid in 1950 less Refund	15	15	0						
										733	8	6
31	5	0	,, Sales of Transactions ..							16	5	0
12	10	0	,, Accrued Interest on Savings Certificates							12	10	0
17	5	4	,, Interest on 2½% Consolidated Stock							17	5	4
1	1	0	,, Special Contribution to General Fund							—		
518	9	1	,, Excess of Expenditure over Income for the year ..							91	10	0
£1,314	14	4								£870	18	10

THE BRITISH SOCIETY FOR THE STUDY OF ORTHODONTICS

BALANCE SHEET as at 30th September, 1950

1949										1949									
£	s.	d.		£	s.	d.	£	s.	d.	£	s.	d.		£	s.	d.	£	s.	d.
			Accumulated Fund:—										*Furniture and Office Equipment:*						
1,618	2	9	Balance at 1st Oct., 1949 ..	1,099	13	8							Balance at 1st Oct., 1949 ..	519	15	6			
			Less: Excess of Expenditure over Income for the year										*Less:* Depreciation at 5% per annum on cost	30	11	6			
518	9	1	to date	91	10	0				519	15	6					489	4	0
1,099	13	8					1,008	3	8				*Debtors:*						
			Creditors:—										1950 Subscriptions received since						
			Transactions 1949 and 1950							7	7	0	30th September, 1950				7	17	6
			(Estimated by Hon. Tres-										*Investments:*						
1,255	0	0	surer)	1,000	0	0							500 National Savings Certificates						
22	10	0	Hire of Hall	22	10	0				375	0	0	Seventh Issue at cost ..	375	0	0			
7	17	6	Storage Rent	7	17	6				25	0	0	*Add:* Accrued Interest to date	37	10	0			
11	0	0	Refreshments	11	0	0								412	10	0			
9	9	0	Subscriptions in Advance	10	9	0							£691 5s. 10d. 2½% Consolidated						
3	11	3	Journals	—						575	14	0	Stock at cost	575	14	0			
							1,051	16	6				(*Approximate Market Value* £935)				988	4	0
	2	3	*Petty Cash*—Overdrawn ..										*Cash at Bank:*						
										906	3	9	Westminster Bank Limited ..	171	1	9			
										—			Post Office Savings Bank ..	400	0	0			
																	571	1	9
													Cash in Hand:						
											3	5	Hon. Treasurer	2	1	1			
											—		Hon. Secretary	1	11	10			
																	3	12	11
£2,409	3	8					£2,060	0	2	£2,409	3	8					£2,060	0	2

S. B. NEWTON
T. L. WINN } *Hon. Auditors.*

HAROLD CHAPMAN, *Hon. Treasurer.*

Certified in accordance with the Books and Vouchers of the Society
We have verified the Investments and Cash at Bank.

FREDK. B. SMART & Co.,
Chartered Accountants.
22, Queen Street,
London, E.C.4.

8th November, 1950

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